US Army Corps
of Engineers
New England Division

Water Resources Development

New Hampshire 1991

The work of the U.S. Army Corps of Engineers in New Hampshire 1991

This booklet presents a brief description of water resources projects completed by the U.S. Army Corps of Engineers in New Hampshire. It describes the role of the Corps in planning and building water resource improvements and explains the procedure leading to the authorization of such projects.

For ease of reference, the material is arranged according to the type of project, i.e. flood damage reduction, navigation, or shore and bank protection. There is also a reference at the end of the booklet that lists Corps' projects by community. A map showing the location of all Corps projects in the state is provided on the underleaf of this page.

The Corps of Engineers water resources development program exerts a significant impact on New Hampshire's physical, economic, and social environment. This publication affords citizens the opportunity to learn about the various projects and to determine how they can participate in decisions regarding present and future activities.

For further information, call the Corps of Engineers at 617-647-8777, or write:

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US Army Corps of Engineers
New England Division

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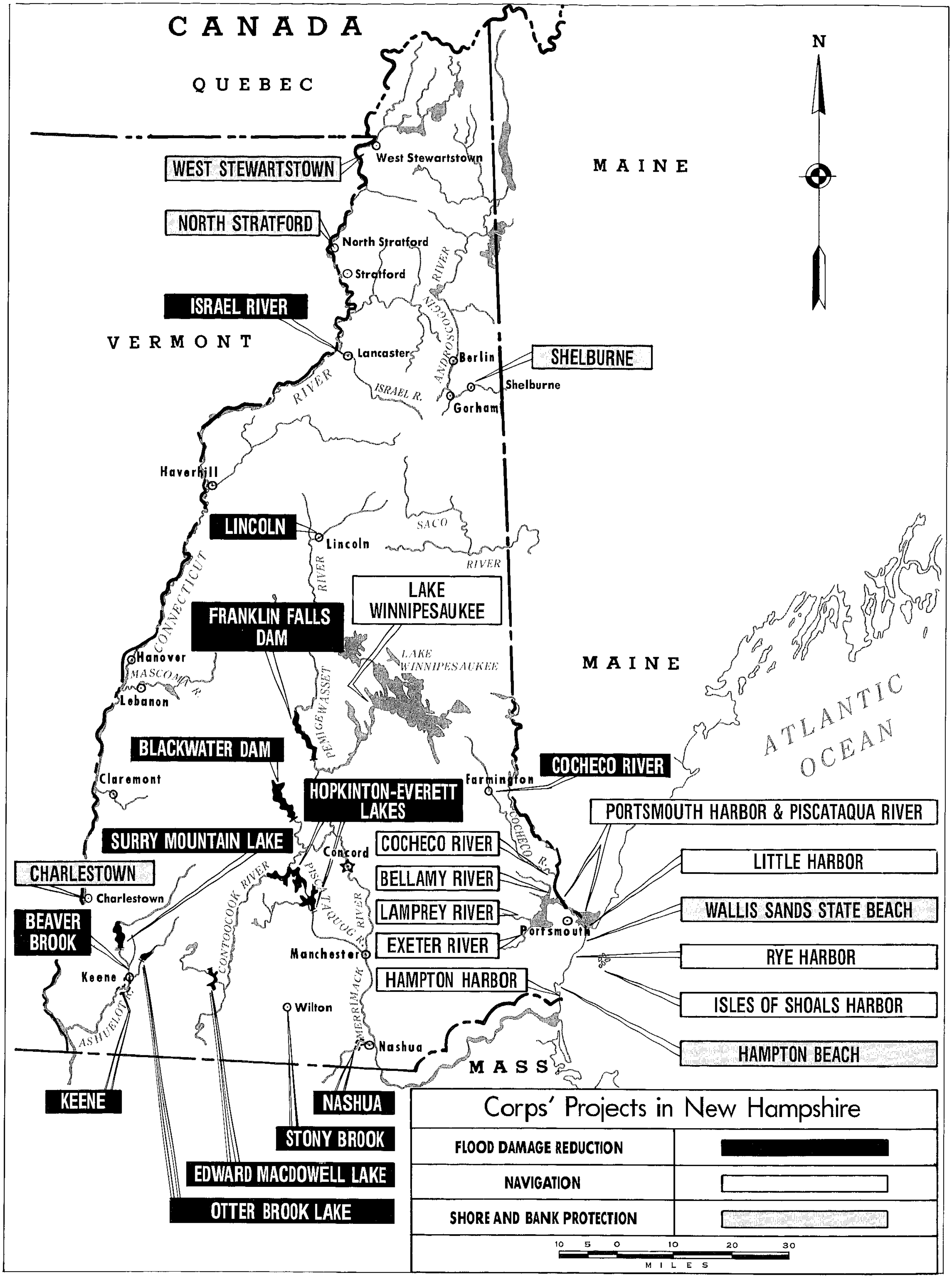

CANADA
QUEBEC
VERMONT
MAINE
MAINE
MASS
ATLANTIC OCEAN
N
WEST STEWARTSTOWN
NORTH STRATFORD
ISRAEL RIVER
SHELBURNE
LINCOLN
LAKE WINNIPESAUKEE
FRANKLIN FALLS DAM
BLACKWATER DAM
HOPKINTON-EVERETT LAKES
COCHECO RIVER
PORTSMOUTH HARBOR & PISCATAQUA RIVER
SURRY MOUNTAIN LAKE
CHARLESTOWN
COCHECO RIVER
BELLAMY RIVER
LAMPREY RIVER
EXETER RIVER
HAMPTON HARBOR
LITTLE HARBOR
WALLIS SANDS STATE BEACH
RYE HARBOR
ISLES OF SHOALS HARBOR
HAMPTON BEACH
BEAVER BROOK
KEENE
NASHUA
STONY BROOK
EDWARD MACDOWELL LAKE
OTTER BROOK LAKE
West Stewartstown
North Stratford
Stratford
Lancaster
Berlin
Shelburne
Gorham
Haverhill
Lincoln
Hanover
Lebanon
Claremont
Farmington
Concord
Charlestown
Portsmouth
Manchester
Keene
Wilton
Nashua
ANDROSCOGGIN RIVER
ISRAEL R.
RIVER
CONNECTICUT
SACO RIVER
PEMIGEWASSET RIVER
LAKE WINNIPESAUKEE
MASCOMA R.
COCHECO R.
CONTOOCOOK RIVER
PISCATAQUOG R.
RIVER
MERRIMACK
ASHUELOT R.
Corps' Projects in New Hampshire
FLOOD DAMAGE REDUCTION
NAVIGATION
SHORE AND BANK PROTECTION
10 5 0 10 20 30
MILES

US Army Corps of Engineers
New England Division

For more than 216 years, the missions and accomplishments of the U.S. Army Corps of Engineers have closely reflected the needs and wants of a growing, changing nation. For much of this time, the Corps has played a major role in our nation's water resources development, including navigation, flood control, water quality and supply, recreation and related projects.

Although the driving force behind our water resources development mission has remained constant—providing quality service to the nation there have been several challenging adjustments in how we meet this requirement.

One such change was the introduction of non-federal cost sharing in the Water Resources Development Act. Though legislatively reaffirmed in the subsequent acts of 1988 and 1990, the true value of cost-shared development can be measured by the many successful projects of this partnership and the healthy water resources program it ensures for the future.

Another challenge we have faced recently is the increased public concern for their environment. We have always complied with environmental laws and regulations and managed our projects as a trust we hold for the future. Compliance, however, is no longer enough. We are taking an active position to not only protect but enhance our fragile environment.

The Secretary of the Army has been directed to include environmental protection as one of our primary missions, and the Water Resources Development Act of 1990 established a "no net loss" policy as an essential part of all water resources development. In addition to making environmental considerations as important as engineering and economic considerations for new start projects, we are taking a new look at existing projects to determine how they can be environmentally improved.

Looking ahead to the needs of our nation, we are taking a lead role in helping rebuild our nation's aging infrastructure. The U.S. Army Corps of Engineers has always been at the forefront of infrastructure development in the United States exploring new territory for settlement, surveying transportation routes and opening rivers to navigation. While we work to restore and strengthen the vital links in our infrastructure, we are also exploring new methods to meet increasing and varying national requirements. One such effort is a joint federal, non-federal demonstration project to determine the feasibility of a U.S. developed and built high-speed magnetic levitation transportation system.

We have also been working actively with the construction industry on a cost-shared Construction Productivity Advancement Research Program. This program has the double benefits of increasing the U.S. construction industry's competitive ability in the international market while providing more effective techniques, equipment and processes for federal and non-federal projects in the United States

With these initiatives, we are building on the Corps' traditions of professionalism and service to meet the needs of our nation for another 200 years. We are proud of the partnerships we have forged, and look forward to an exciting, rewarding future in water resources development.

This booklet is one in a series detailing water resources programs in the 50 states and U.S. possessions. I hope you find it interesting and feel some pride of ownership.

H.J. HATCH
Lieutenant General, USA
Commanding

US Army Corps of Engineers
New England Division

The U.S. Army Corps of Engineers has a long and proud history of applying its expertise in engineering and related disciplines to meet the Nation's needs. Over the years, those needs have evolved, from such 19th Century activities as exploration, pathfinding and lighthouse construction to such modern missions as hazardous and toxic waste removal and environmental improvement. The central focus of its Civil Works mission, however, has, from its earliest days, been development of the Nation's water resources.

The water resource projects developed by the Corps of Engineers, in cooperation with State and local project sponsors, have proven themselves time and again as wise investments of public funds, returning to the public in benefits—low cost transportation, flood damages prevented, etc.—far more than their cost to plan, build and operate. As a result, the Civil Works program enjoys a high degree of credibility within the Administration, and with Congress. With a program of more than $3.5 billion in Fiscal Year 1991, the Civil Works program was one of the very few "domestic discretionary" activities of the Federal government to receive an increase in funding that year.

Yet, proud as we are of the respect this program commands within the Federal government, we are even prouder of the trust that our partners the States, local governments, port authorities, water management districts and other local project sponsors place in us.

Each Corps of Engineers project is the product of an orderly study and design process. Under provisions of the Water Resources Development Act of 1986, sponsors demonstrate their commitment early in the project development process by agreeing to joint funding of the feasibility study upon which a project's construction authorization will be based, and to cost sharing of the project's construction once it is authorized. To date, more than 150 non-Federal sponsors have signed Local Cooperation Agreements for studies or congressionally authorized projects.

The engineering expertise and responsiveness of the Corps of Engineers, gained in the Civil Works and Support for Others programs as well as in its military construction role, has stood the Nation in good stead from Alaska, where it participated in the oil spill cleanup; to Puerto Rico, the Virgin Islands and the Southeastern States, where it spearheaded recovery efforts after Hurricane Hugo; to California in the aftermath of the Loma Prieta Earthquake; to the Midwest and California as they deal with continuing drought; to Panama and the Middle East in Operations JUST CAUSE and DESERT SHIELD/DESERT STORM; to dozens of other locations. Whatever challenges arise in the years and decades ahead, I have no doubt that the Army Corps of Engineers will be equal to the task.

G. Edward Dickey
Acting Principal Deputy
Assistant Secretary of the
Army (Civil Works)

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U.S. ARMY CORPS OF ENGINEERS

PROGRAMS AND SERVICES

CIVIL WORKS OVERVIEW

Introduction

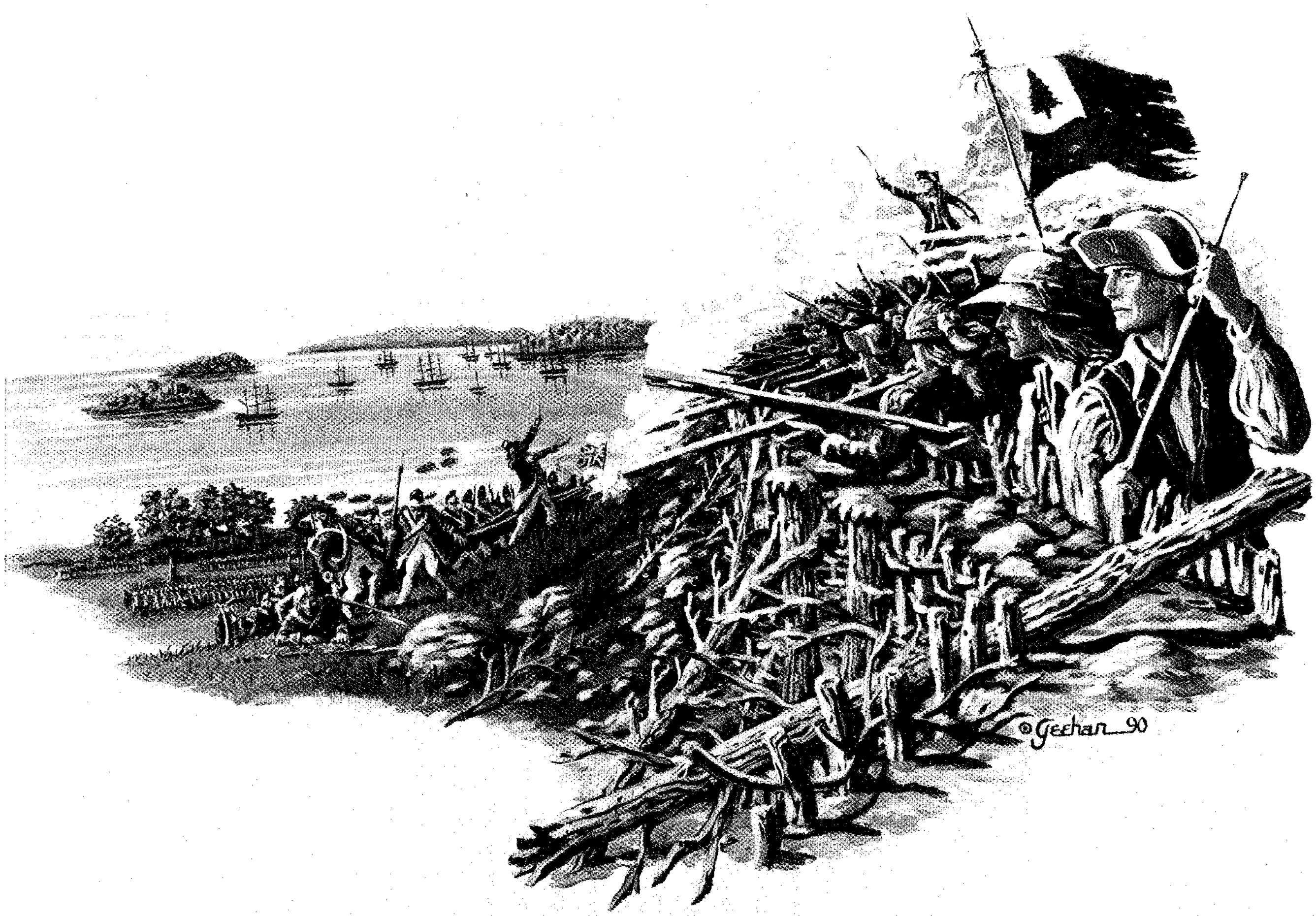
The Corps traces its history back to April 26, 1775, seven days after the first shots of the American Revolution were fired at Lexington, Massachusetts. Recognizing that the need for military engineering skill would be important in the war with England, the Massachusetts Provincial Congress appointed Boston native Richard Gridley to the rank of Colonel and chief engineer of the troops being raised in the colony.

In the early morning hours of June 17, 1775, Gridley, working under the cover of darkness, constructed a well-designed earthwork on Breed's Hill that proved practically invulnerable to British cannon. The British eventually took the hill (later called the Battle of Bunker Hill) when the patriots ran out of gunpowder, but at a cost in casualties greater than any other engagement of the war.

Gridley was to play other critical roles in the early days of the Revolution. On the evening of March 4, 1776, Gridley, along with 2000 men and 360 oxcarts loaded with entrenching materials, moved into Dorchester Heights. By daylight, two strong protective barriers looked down at the British. An astonished General Howe, commander of the British forces, reportedly remarked that the Americans had done more in one night than his entire army would have done in six months. Exposed to the American batteries on Dorchester Heights and not strong enough to fight Washington's troops in other parts of Boston, the British army and fleet departed Boston on March 17, never again to occupy Massachusetts.

In 1802, Congress established a separate Corps of Engineers within the Army, and at the same time established the U. S. Military Academy at West Point, the country's first—and for 20 years its only—engineering school. With the Army having the Nation's most readily available engineering talent, successive Congresses and Administrations established a role for the Corps as an organization to carry out both military construction and works "of a civil nature."

Throughout the nineteenth century, the Corps supervised the construction of coastal fortifications, lighthouses, several early railroads, and many of the public buildings in Washington, DC, and elsewhere. Meanwhile, the Corps of

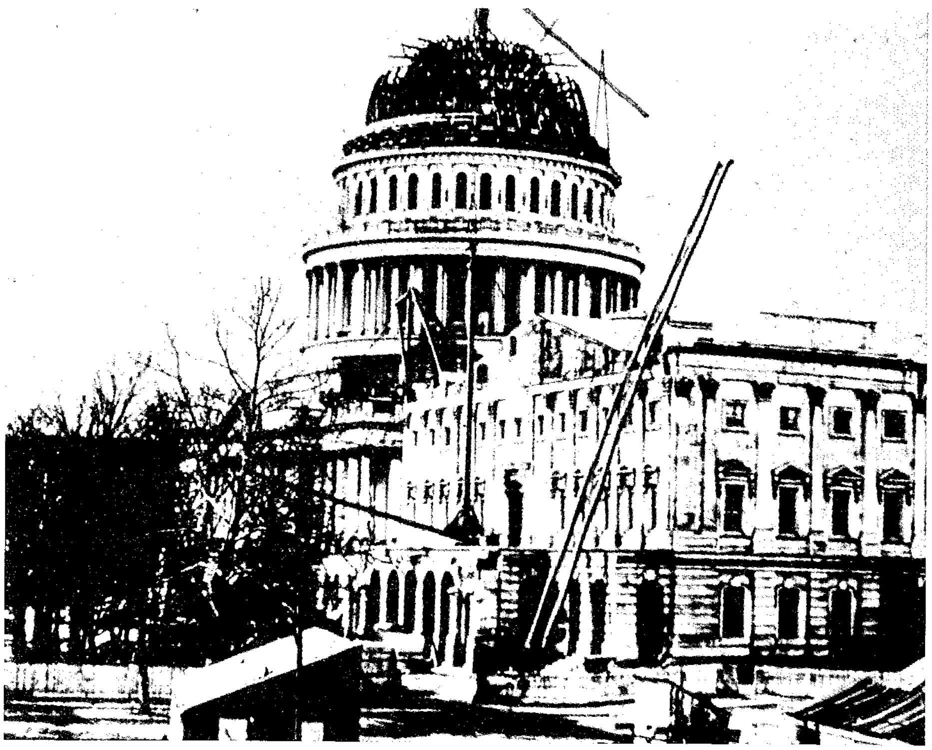


Under the direction of Colonel Richard Gridley, American patriots worked diligently throughout the early morning hours of June 17, 1775, designing a stout earthwork fortification that helped protect American soldiers from British cannonade in the historic Battle of Bunker Hill.

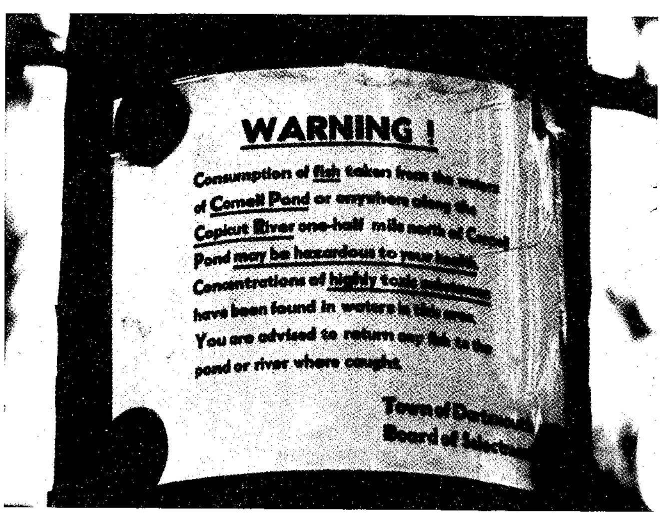
Topographical Engineers, which enjoyed a separate existence for 25 years (1838-1863), mapped much of the American West. Army Engineers served with distinction in war, with many Engineer officers rising to prominence during the Civil War.

In its civil role, the Corps of Engineers became increasingly involved with river and harbor improvements, carrying out its first harbor and jetty work in the first quarter of the nineteenth century. The Corps' ongoing responsibility for federal river and harbor improvements dates from 1824, when Congress passed two acts authorizing the Corps to survey roads and canals and to remove obstacles on the Ohio and Mississippi Rivers. Over the years since, the expertise gained by the Corps in navigation projects made it a natural to assume new water-related missions in such areas as flood control, shore and hurricane protection, hydropower, recreation, water supply and quality, and wetland protection.

Today's Corps of Engineers carries out missions in three broad areas: military construction and engineering support to military installations; reimbursible support to other Federal agencies (such as the Environmental Protection Agency's "Superfund" program to clean up hazardous and toxic waste sites); and the Civil Works mission, centered around navigation, flood control and—under the Water Resources Development Acts of 1986 and 1990 a growing role in environmental protection.



Army engineers contributed to both planning and construction of our nation's capital. When the Capitol Building had to be reconstructed in 1857, the Corps built two new wings and redesigned the dome with cast and wrought iron. The completed dome, which weighed almost nine million pounds, was used by President Abraham Lincoln during the Civil War as a symbol of his intention to preserve the Union.



Cleaning chemical spills at hazardous waste sites is a team project between the Corps and the EPA. An area identified as a hazardous waste location was this site in Dartmouth, Massachusetts, near Cornell Pond and the Copicut River.

Authorization and Planning Process for Water Resources Projects

Water resources activities are initiated by local interests, authorized by Congress, funded by Federal and non-Federal sources, and constructed by the Corps under the Civil Works Program. New England Division has water resource responsibilities in all six New England states. The area assigned to New England Division contains 66,000 square miles, 13 million people, 6,100 miles of coastline, 13 major river basins and 11 deep draft commercial ports.

The Water Resources Development Act of 1986 made numerous changes in the way potential new water resources projects are studied, evaluated and funded. The major change is that the law now specifies non-Federal cost sharing for most Corps water resources projects.

When local interests feel that a need exists for improved navigation, flood protection, or other water resources development, they may petition their representatives in Congress. A Congressional committee resolution or an Act of Congress may then authorize the Corps of Engineers to investigate the problems and submit a report. Water resources studies, except studies of the inland waterway navigation system, are conducted in partnership with a local sponsor, with the Corps and the sponsor jointly funding and managing the study.

For inland navigation and waterway projects, which are by their nature not "local," Congress has established, in the Water Resources Development Act of 1986, an Inland Waterway Users Board, comprised of waterway transportation companies and shippers of major commodities. This Board advises the Secretary of the Army and makes recommendations on priorities for new navigation projects (e.g., locks and dams, channel improvements, etc.). Such projects are funded in part from the Inland Waterway Trust Fund, which in turn is fed by waterway fuel taxes.

Normally, the study process for a water resource problem will include public meetings to determine the views of local interests on the extent and type of improvements desired. The desires of local interests and the views of Federal, State, and other agencies receive full consideration during the planning process.

Considerations which enter into recommendations to Congress for project authorization include determinations that benefits will exceed costs, and that the engineering design of the project is sound, best serves the needs of the people concerned, makes the wisest possible use of the natural resources involved, and adequately protects the environment.

A report, along with final environmental documentation, is then submitted to higher authority for review and recommendations. After review and coordination with all interested Federal agencies and Governors of affected States, the Chief of Engineers forwards the report and environmental statement to the Secretary of the Army, who obtains the views of the Office of Management and Budget before transmitting these documents to Congress.

If Congress includes the project in an authorization bill, enactment of the bill constitutes authorization of the project. Before construction can get underway, however, both the Federal government and the local project sponsor must provide funds. Budget recommendations are based on evidence of support by the State and by the ability and willingness of non-Federal sponsors to provide their share of the project cost.

Appropriation of money to build a particular project is usually included in the annual Energy and Water Development Appropriation Bill, which must be approved by both Houses of the Congress and the President.

Navigation

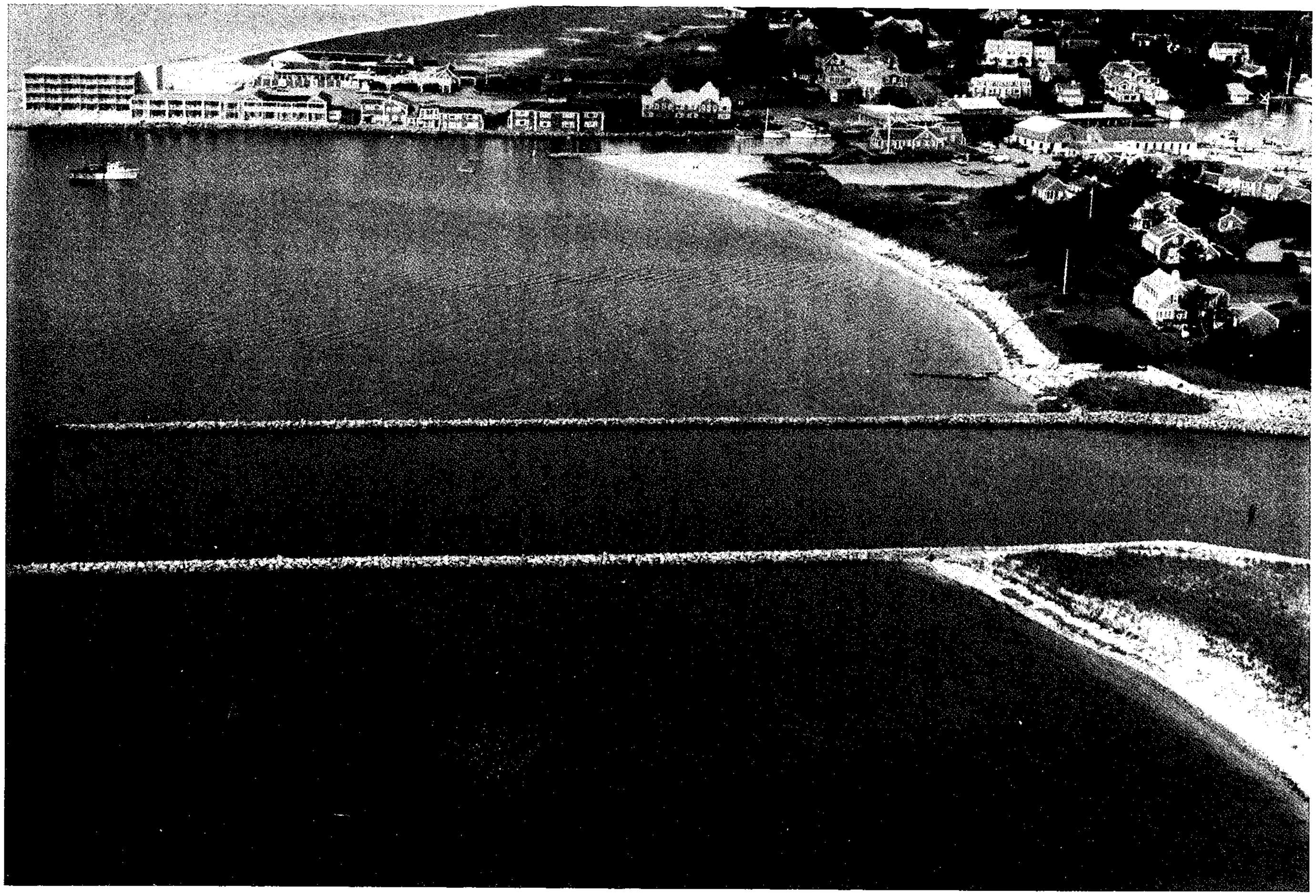
Rivers and waterways were the primary paths of commerce in the new country. They provided routes from western farms to eastern markets. They promised a new life to the seaboard emigre and financial reward for the Mississippi Valley merchant. Without its great rivers, the vast, thickly-forested, region west of the Appalachians would have remained impenetrable to all but the most resourceful early pioneers.

Consequently, western politicians such as Henry Clay agitated for federal assistance to improve rivers. At the same time, the War of 1812 showed the importance of a reliable inland navigation system to national defense. Thus, both commercial development and military needs required attention to river and harbor development. There was, however, a question as to whether transportation was, under the Constitution, a legitimate Federal activity. This question was resolved when the Supreme Court ruled that the Commerce Clause of the Constitution granted the Federal Government the authority not only to regulate navigation and commerce, but also to make necessary navigation improvements.

The system of harbors and waterways maintained by the Corps of Engineers remains one of the most important parts of the Nation's transportation system. Without constant supervision, rivers and other waterways collect soil, debris and other obstacles, which lead to groundings and wrecks. New channels and cutoffs appear frequently, and the main traffic lanes require continual surveillance.

Where authorized to do so, the Corps maintains the Nation's waterways as a safe, reliable and economically efficient navigation system. Inland waterways carry one sixth of the Nation's inter-city cargo, and one job in five in the United States is dependent, to some extent, on the commerce handled by the Nation's ports.

River and Harbor work by the Corps of Engineers in New England was initiated by a congressional appropria-



Jetties help provide safe channels for commercial and recreational vessels. The jetties at Saquatucket Harbor in Harwich, Massachusetts, also help prevent the buildup of sediment in the channel by directing and confining the tidal flow.

tion of $20,000 on May 26, 1824 "to repair Plymouth Beach, in the State of Massachusetts, and thereby prevent the harbour at that place from being destroyed." From that initial project at America's first permanent settlement, New England Division has completed 173 navigation projects , including federal navigation projects in 11 deep draft ports and adjacent waterways. The most visible of The Corps navigation responsibilities is the Cape Cod Canal, which has been operated by the federal government since 1928. The canal is 17.5 miles long and is traversed by 19,000 vessels annually. In addition, its recreation features attract over 4 million annual visitors to the project.

Flood Control and Flood Plain Management

Federal interest in flood control began in the Alluvial Valley of the Mississippi River in the 19th Century. As the relationship of flood control and navigation became apparent, Congress called on the Corps of Engineers to use its expertise in navigational work to devise solutions to flooding problems along the river.

After a series of disastrous floods affecting wide areas, including transportation systems, in the 1920's and 30's, it was recognized that the Federal Government should participate in the solution of problems affecting the public interest when they are too large or complex to be handled by States or localities. As a result, Corps authority for flood control work was extended in 1936 to embrace the entire country.

The purpose of flood control work is to prevent flood damage through flood flow regulation and other means. In addition, the Flood Control Act of 1944 provided that "flood control" shall include major drainage of land. These objectives are accomplished with structural measures, such as reservoirs, levees, channels and floodwalls, or non-structural measures which alter the way people would otherwise occupy or use the flood plain. Levees, channel improvements and flood walls built for flood control by the Corps of Engineers are turned over to non-Federal authorities for operation and maintenance.

Reservoirs constructed for flood control storage often include additional storage capacity for multiple-purpose uses, such as the storage of water for municipal and industrial use, navigation, irrigation, development of hydroelectric power, conservation of fish and wildlife, and recreation.

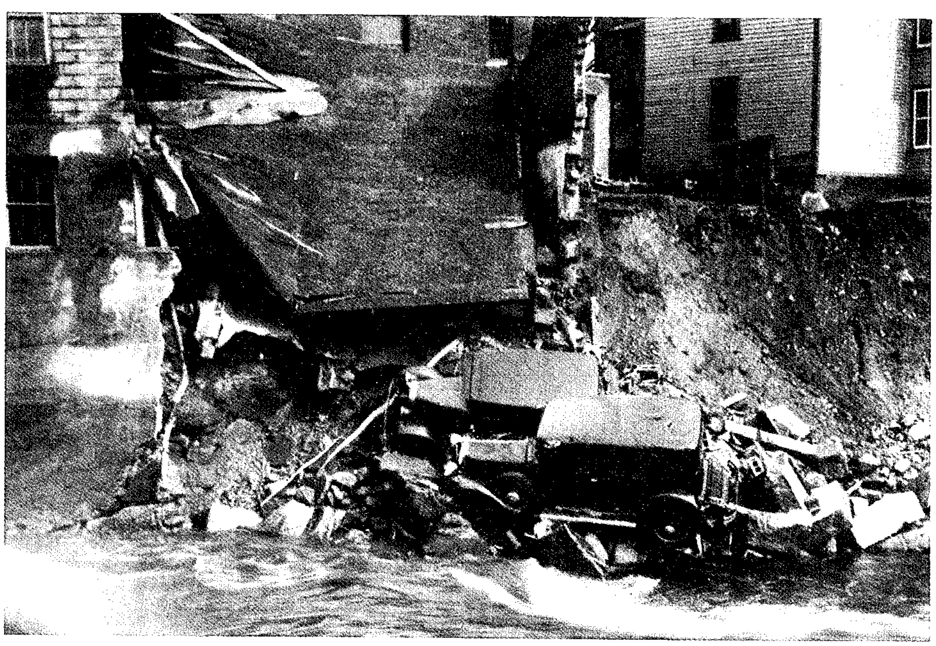
The Corps fights the Nation's flood problems by not only constructing and maintaining flood control structures, but also by providing detailed technical information on flood hazards. Under the Flood Plain Management Services Program, the Corps provides, on request, flood hazard information, technical assistance and planning guidance to other Federal agencies, States, local governments and private individuals. This information is designed to aid in planning for floods and regulation of flood plain areas, thus avoiding unwise development in flood-prone areas. Once community officials know the flood- prone areas in their communities and how often floods would be likely to occur, they can take necessary action to prevent or minimize damages to existing and new buildings and facilities by adopting and enforcing zoning ordinances, building codes and subdivision regulations. The Flood Plain Management Services Program also provides assistance to other Federal agencies and to State agencies in the same manner. In many cases, fees are collected to cover a portion of the costs of these services.

Flooding in New England

New England has a long history of flooding. Through the years it has been hit with various storms that have caused millions of dollars in damages. Some of the more destructive hurricanes and floods the area has experienced since 1900 occurred in November 1927; March 1936; September 1938; September 1954; and August 1955. However, some of the highest flood levels in New England history occurred in April 1987 and gave many Corps dams their most serious test since they were built. Despite having six dams channel excess water through their emergency spillways because their reservoir capacities had been reached, the 35 dams under the jurisdiction of the Corps' New England Division held back billions of gallons of water that otherwise would have caused severe flooding downstream. The amount of water held back by these dams from this heavy rainfall was equivalent to a reservoir that could put the entire state of Rhode Island under more than one foot of water. Damages prevented by Corps flood control projects during the April 1987 storm amounted to $462.6 million.

1927

Floodwaters swirl around homes and trees in this Vermont community during the November 1927 flood. The storm claimed 21 lives and caused $29.3 million in property damage.



1936

The rampaging waters of the North Nashua River ripped through the downtown area of Fitchburg, Massachusetts, during the March 1936 flood, taking with it homes, automobiles, and commercial and industrial property. Eleven lives were lost from this flood and damages were estimated at $66.4 million.

1936

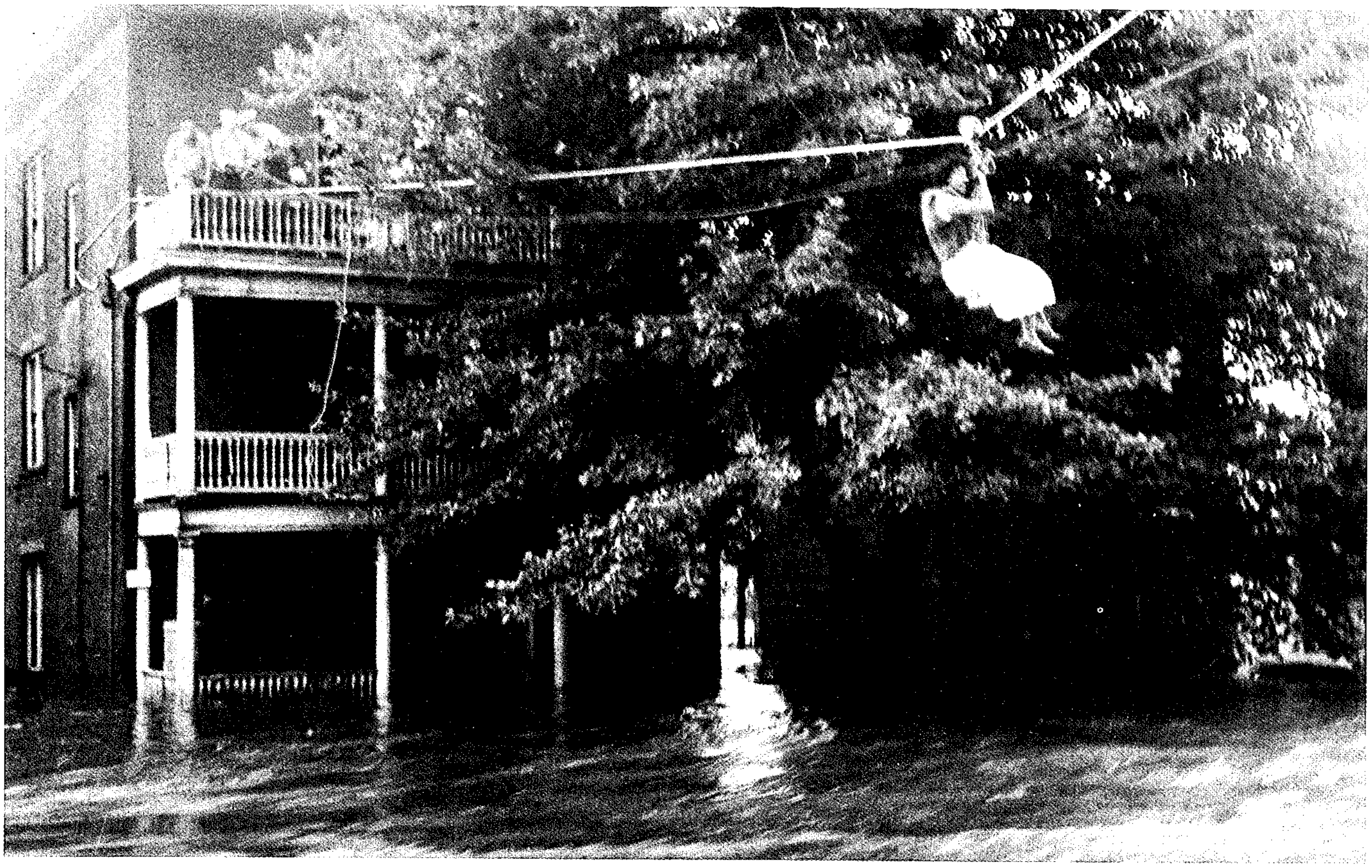
Waters from the Connecticut River surround the Hartford South Meadows Power Station (center) and cover much of Hartford, Connecticut, during the March 1936 flood. The spring floods of 1936 brought widespread disaster from Maine to Maryland and helped mold political and public opinion that culminated in the Flood Control Act of 1936, which recognized the proper involvement of the federal government in flood control. (Copyright 1936 The Hartford Courant*).*

1938

The heavy rains of the September 1938 hurricane caused the Contoocook River to flood a section of East Jaffrey, New Hampshire. This storm, with its 121 m.p.h. gusts, took the lives of eight people in New England and caused damages of $48.6 million (about $740 million in today's dollars).

1954 *Hurricane Carol, which struck the New England coast in August 1954, caused damages estimated at $186 million ($685 million in today's dollars). The storm achieved its greatest fury in a band stretching from New London, Connecticut to the Cape Cod Canal. All that remains of the Rhode Island Yacht Club (above) in the Pawtuxet Neck section of Warwick, Rhode Island, is a cradle of piles after the structure was destroyed by Carol's high winds and waves. (Copyright 1954* The Providence Journal Company*).*

1955 *The Blackstone River overflows its banks and floods several businesses and homes in Pawtucket, Rhode Island as a result of the heavy rains of Hurricane Diane in August 1955.*



1955

No natural disaster in New England history compares with the devastation caused by the sudden and torrential rainfall which accompanied Hurricane Diane in August 1955. The disaster killed 90 people and caused almost $458 million (about $1.82 billion in today's dollars) in property damage throughout the six-state region. In Connecticut alone, Diane's floodwaters killed 47 people and caused damages totalling about $370 million (about $1.3 billion in today's dollars). The rains of Hurricane Diane fell on ground already saturated by the rains of Hurricane Connie one week earlier.

One of the communities that sustained heavy damage was Winsted, Connecticut. The waters of the Mad River overflowed its banks and roared through Main Street, uprooting foundations and flooding homes and businesses. When the floodwaters receded, the devastation became apparent (right). Main Street had become a pile of rubble, cluttered with debris ripped from its understructure.

The storm also forced hundreds of New Englanders to evacuate their homes, including a Connecticut woman (above) who was dramatically rescued from ravaging floodwaters. (Copyright 1955 The Hartford Courant*).*

Only two months later, as Connecticut was getting back on its feet, another severe flood disrupted rehabilitation measures and caused losses estimated at $6.5 million. In response to these major floods, the Corps built several dams and local protection projects that, in a recurrence of the August 1955 flood today, would prevent damages of $1.04 billion

1955 *As these photos from August 1955 demonstrate, floodwaters pose a powerful threat to property and lives. As the top photo shows, this Southbridge, Massachusetts home was toppled when the floodwaters of the Quinebaug River weakened its foundation. Note the overturned automobile on the left; its only identifiable remains are its tires.*

Floodwaters from the Blackstone River (above) roar through Webster Square in Worcester, Massachusetts.

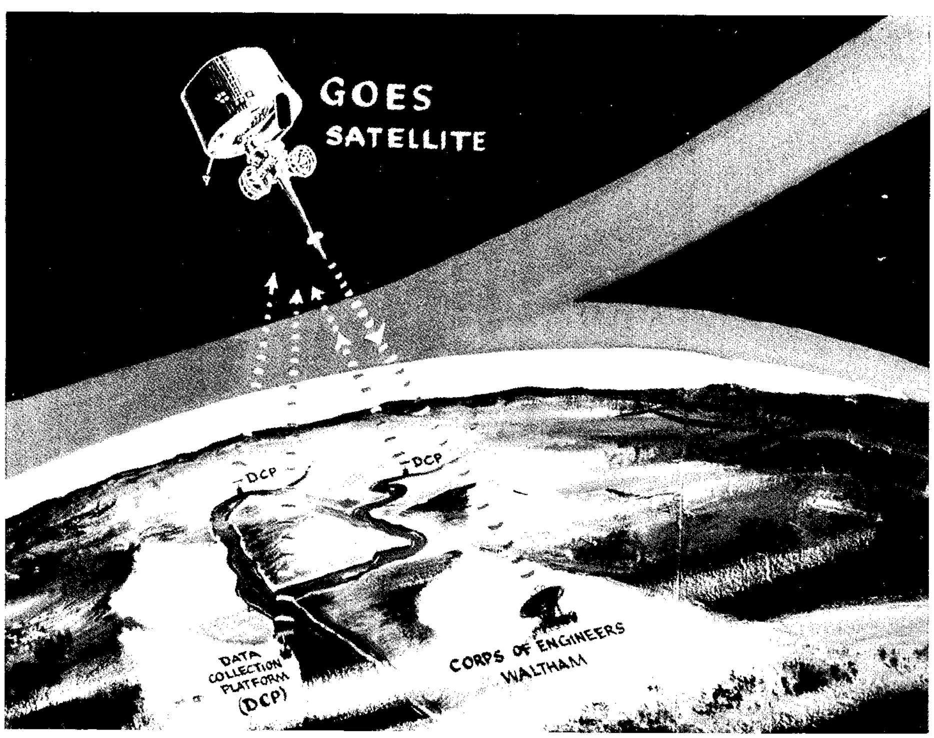
Reservoir Control Center

As a flood situation develops, considerable judgment and experience are required to efficiently manage Corps dams and reservoirs. Weather conditions, reservoir storage capacity, and the flood levels of rivers are important factors when operating dams that maximize the protection of downstream communities and minimize flood damage. The nature of New England weather requires the region's dams and reservoirs be professionally managed by trained engineers and hydrologists. These skilled technicians, using sophisticated communications equipment, form an integral part of the Corps' flood control efforts known as the Reservoir Control Center (RCC).

The RCC is located at the Corps' New England headquarters in Waltham, Massachusetts. From this site, Corps engineers closely monitor precipitation, river levels, and tidal levels in New England. The state-of-the-art communications equipment used by RCC personnel is complemented by the Geostationary Operational Environmental Satellite (GOES) System. The GOES system serves as a communication link for the relay of hydrologic and meteorological data. Information from about 50 data collection platforms at key locations along rivers, streams and other bodies of water is relayed to a stationary satellite, which transmits this data by radio signal to the RCC. Engineers then examine and analyze this hydrologic information for potential flood conditions. This data indicates when to operate the flood control gates and when to release stored floodwaters from reservoirs once downstream flood conditions have receded. During flood emergency periods, additional information is obtained by telephone, teletype, and radio from field personnel and other agencies, such as the National Weather Service and the U.S. Geological Survey.

The Reservoir Control Center has helped minimize or prevent severe and damaging floods in many New England communities. The Corps is proud of its commitment to provide the public with improved flood protection through the professional management of its dams and hurricane protection barriers.

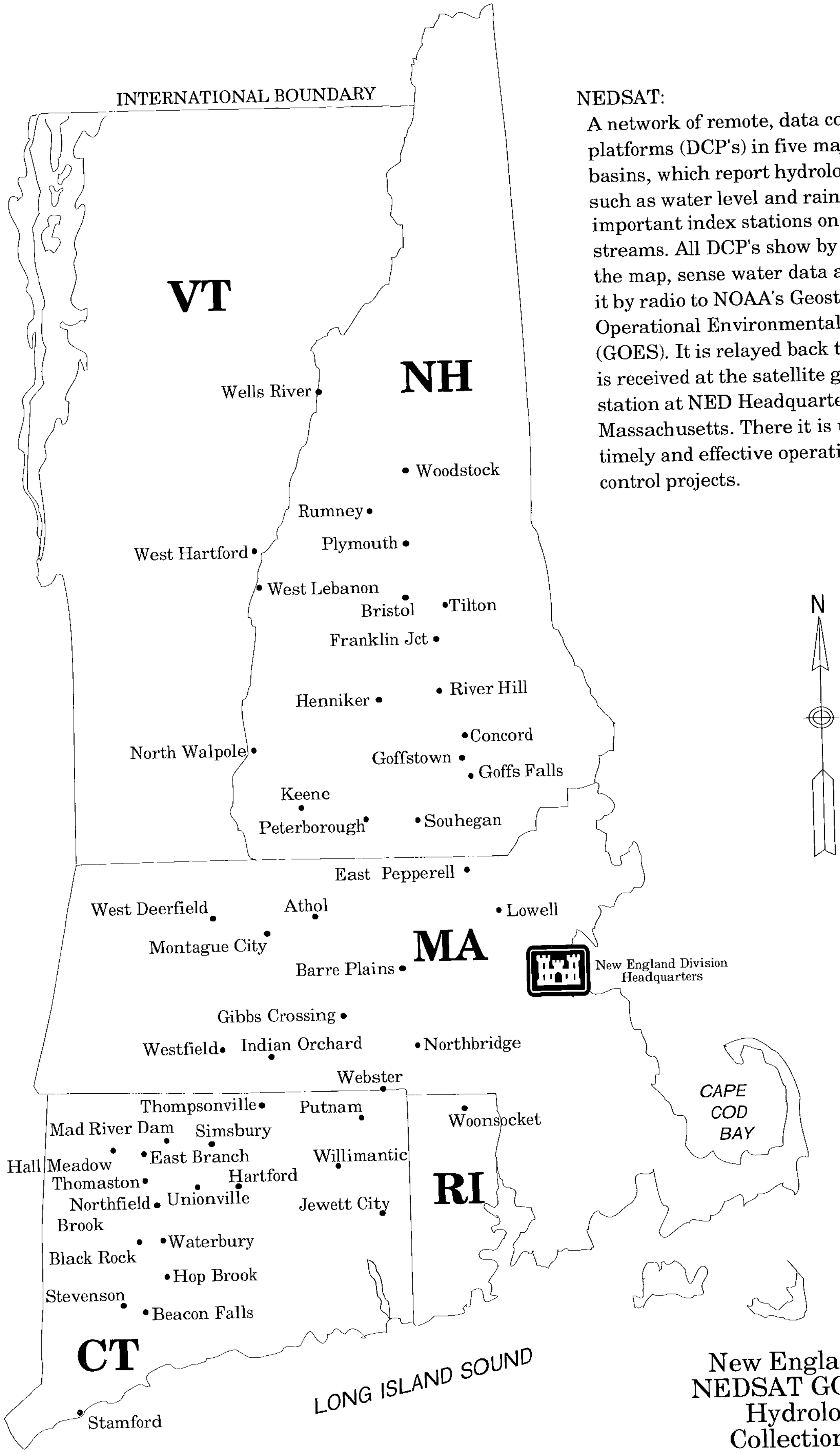
New England Division has been an innovative leader in the use of non-structural solutions for flooding problems. The Charles River Natural Valley Storage Project provides a novel approach to flood protection in parts of Boston and Cambridge by retaining flood flows on 8,100 acres of wetland areas aquired by the government at a cost of $9 million. In Warwick, Rhode Island flood-prone properties were aquired, removed or modified to withstand high water events with the federal government underwriting 80% of the cost. In these times of environmental concern and building restrictions, non-structural flood protection projects have the potential to protect life and property with minimal adverse environmental impacts.



The GOES network, or the New England Division Satellite System (NEDSAT), plays a key role in helping the Corps reduce flood damage. About 50 data collection platforms (DCPs) are situated on various rivers and streams throughout the five New England states (opposite page) where the Corps has dams and hurricane protection barriers. Hydrologic and meteorological data from these DCPs are relayed to a satellite stationed above the earth (right). The satellite then transmits this information by radio signal to the Corps' Reservoir Control Center in Waltham, Massachusetts. The data tell Corps' engineers when to open or close the floodgates of Corps' dams and hurricane protection barriers, thus limiting damage to communities downstream. The GOES system also provides the national weather maps displayed by local TV weathermen during their forecasts.

NEDSAT:

A network of remote, data collection platforms (DCP's) in five major river basins, which report hydrologic data, such as water level and rainfall, from important index stations on rivers and streams. All DCP's show by dots on the map, sense water data and transmit it by radio to NOAA's Geostationary Operational Environmental Satellite (GOES). It is relayed back to Earth, and is received at the satellite ground station at NED Headquarters in Waltham, Massachusetts. There it is used for timely and effective operation of flood control projects.



New England Division
NEDSAT GOES Satellite
Hydrologic Data
Collection Network

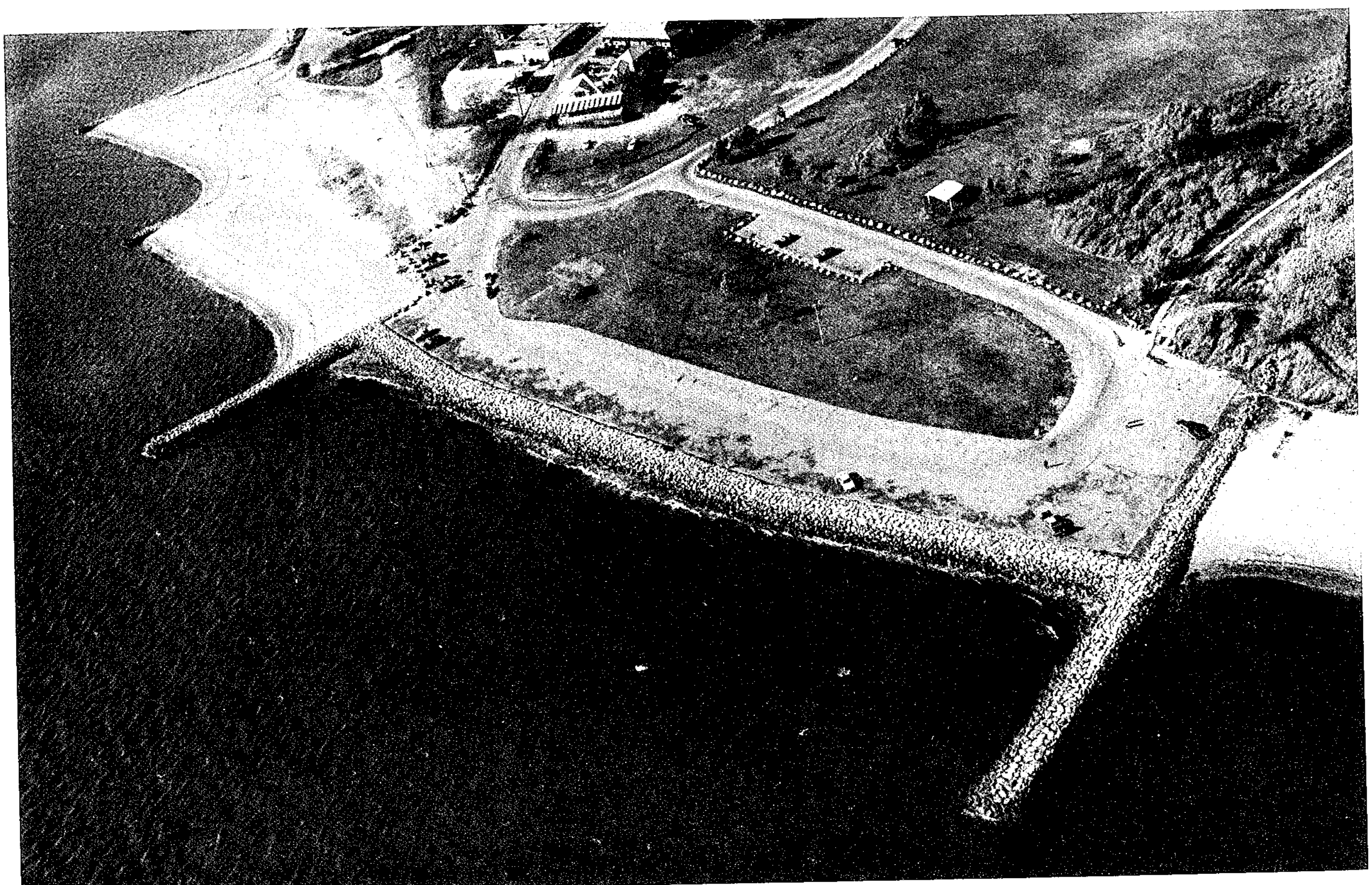
Shore and Hurricane Protection

The Corps work in shore protection began in 1930, when Congress directed it to study ways to reduce erosion along U.S. seacoasts and the Great Lakes. Corps of Engineers hurricane protection work began in 1955, when Congress directed it to conduct general investigations along the Atlantic and Gulf Coasts to identify problem areas and determine the feasibility of protection.

While each situation the Corps studies requires different considerations, engineers look at each one with structural and non-structural solutions in mind. Engineering feasibility and economic efficiency are considered along with the environmental and social impacts. A recommendation for Federal participation is normally based on shore ownership, use and type and frequency of benefits if there is no public use or benefit, Federal participation is not recommended. Once a shore protection project is completed, non-Federal interests assume responsibility for its operation and maintenance. The New England Division has completed 36 streambank/shoreline protection projects in the region.

New England Division has been a pioneer in the construction of hurricane protection barriers. NED has constructed and operates hurricane barriers in Stamford, CT and New Bedford, MA. Additionally NED has constructed barriers in Providence, R.I.; Pawcatuck, CT; and New London, CT. The local communities have assumed responsibility for their operation and maintenance.

Section 145 of the Water Resources Development Act of 1976 authorizes placement of beach quality sand from our dredging projects on adjacent beaches with local interests picking up the additional costs of the disposal. Section 933 of the Water Resources Development Act of 1986 reduces this local cost share from 100 to 50 percent of additional costs.



This shore protection project at Oakland Beach in Warwick, Rhode Island, is a good example of how Corps' works help protect shores and restore beaches. Sand replenishment, which widened and restored the two beach areas on the far left and far right, slows the ocean's inland advance. The four groins maintain shore alignment by trapping and retaining sand. The stone revetment, in the center of the photograph between two groins, retards erosion.

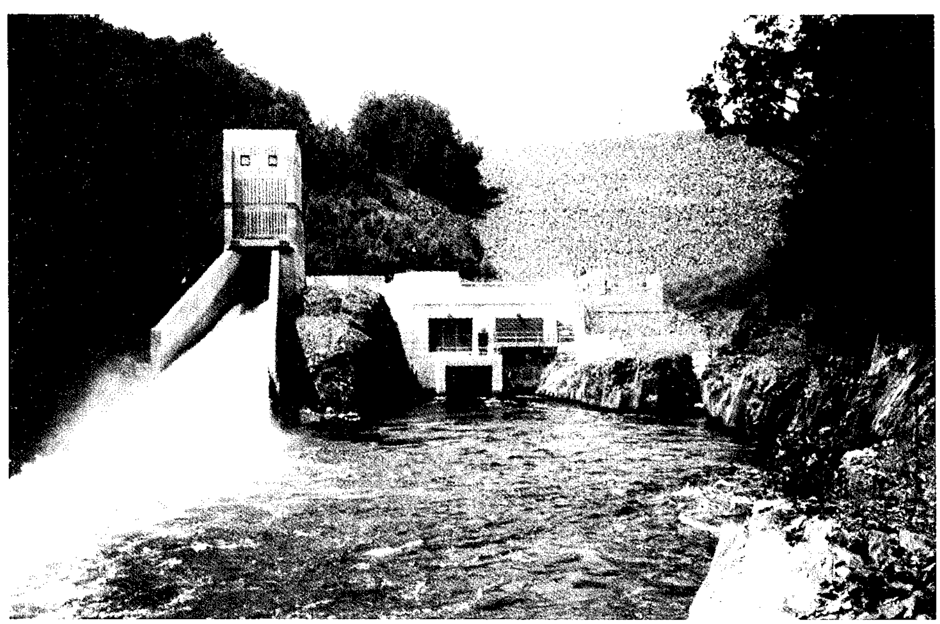
Hydropower

The Corps has played a significant role in meeting the Nation's electric power generation needs by building and operating hydropower plants in connection with its large multiple-purpose dams. The Corps' involvement in hydropower generation began with the Rivers and Harbors Acts of 1890 and 1899, which required the Secretary of War and the Corps of Engineers to approve the sites and plans for all dams and to issue permits for their construction. The Rivers and Harbors Act of 1909 directed the Corps to consider various water uses, including water power, when submitting preliminary reports on potential projects.

The Corps continues to consider the potential for hydroelectric power development during the planning process for all water resources projects involving dams and reservoirs. In most instances, hydropower facilities at Corps projects are now developed by non-Federal interests without Federal assistance, but the Corps becomes involved with the planning, construction and operation of hydropower projects when it is impractical for non-Federal interests to do so. Today, the more than 20,000 megawatts of capacity at corps-operated power plants provide approximately 30 percent of the Nation's hydroelectric power, or 3.5 percent of its total electric energy supply.

In New England, the Corps does not operate any hydroelectric power facilities, but there are eight hydroelectric power plants at Corps flood control dams which are owned and operated by nonfederal interests. These plants are located in:

- *North Hartland, Vermont*, about 500 feet downstream of the North Hartland Lake Dam. This facility produces 4 megawatts of power. All power generated at this plant is used by the Vermont Electric Cooperative or is sold to other utilities.
- *Quechee, Vermont*, 2.5 miles upstream of the North Hartland Lake Dam and within the reservoir area. Built on Corps land, this plant produces 1.8 megawatts. Power is sold to the Central Vermont Public Service Corporation.
- *Waterbury, Vermont*, at the base of the dam at Waterbury Reservoir. This facility generates approximately 5.5 megawatts of power, which is used by the Green Mountain Power Corporation.
- *Montpelier, Vermont*, approximately 200 feet downstream of the dam at Wrightsville Reservoir. The plant has the capacity to produce 1.2 kilowatts of power, which is used by the Washington Electric Cooperative.
- *Franklin, New Hampshire,* on Salmon Brook. Built on Corps land within the Franklin Falls reservoir, this facility produces 0.2 megawatts of power. Power is sold to the Public Service Company of New Hampshire.
- *Bristol, New Hampshire,* on the Newfound River. This plant produces 1.5 megawatts and lies on private property but within the Franklin Falls reservoir area. Power is sold to the Public Service Company of New Hampshire.
- *Peterborough, New Hampshire,* on Verney Mills Dam at Edward MacDowell Lake. This facility began producing power in 1990. The power is sold to the Public Service Company of New Hampshire.



Although the Corps does not presently operate any hydroelectric power plants in New England, there are five hydropower plants located at Corps flood control projects in the region that are owned and operated by nonfederal interests. The North Hartland hydropower facility in North Hartland, Vermont, located 500 feet downstream of the Corps-operated North Hartland Lake Dam, is one such facility.

- *Colebrook, Connecticut,* at the intake of the dam at Colebrook River Lake. This facility began producing power in 1989. The 3.3 megawatts of power is sold to the Connecticut Light and Power Company.

New England Division is evaluating a prototype design for installation of a vertical axis hydro turbine (VAHT) which would harness the energies of the continual tidal currents at the Cape Cod Canal. If installed, the energy generated would offset the current electrical bill. This prototype has widespread repercussions as it does not require the costly superstructure of conventional submerged hydro turbines.

Water Supply

The Water Supply Act of 1958 authorized the Corps to provide additional storage in its reservoirs for municipal and industrial water supply at the request of local interests, provided those interests agree to pay the cost. For irrigation, the Flood Control Act of 1944 provided that the Secretary of War, upon the recommendation of the Secretary of the Interior, may utilize Corps reservoirs, provided that water users agree to repay the Government for the water in accordance with the 1902 Reclamation Law, as amended. Both Littleville and Colebrook Lakes have been designed to provide backup water supplies to surrounding communities in times of severe droughts. Littleville Lake will serve communities in the Springfield, MA area, while Colebrook Lake will serve communities in Northwestern Connecticut.

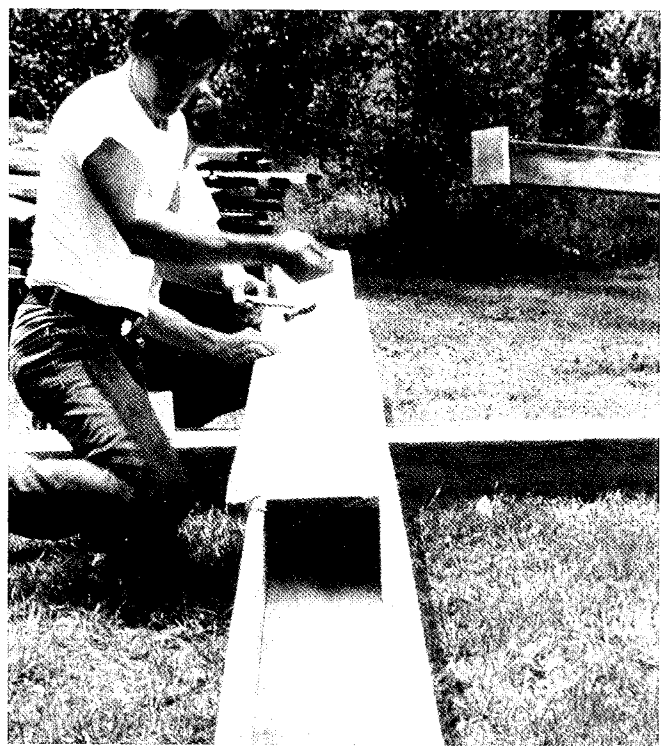
Reservoir capacity can also be used for water quality and streamflow regulation, as authorized by the Federal Water Pollution Control Act Amendments of 1961.

Environmental Quality

In conducting its Civil Works Programs, the Corps must comply with many environmental laws and executive orders and numerous regulations relating to the environment. Consideration of the environmental impact of a Corps project begins in the early stages and continues through design, construction and operation of the project. The Corps must also comply with many of these environmental regulations in conducting its regulatory programs *(see next section).*

The National Environmental Policy Act (NEPA) of 1969 is the national charter for the protection of the environment, and its procedures ensure that public officials and private citizens may obtain and provide environmental information before Federal agencies make decisions concerning the environment. Corps of Engineers project planning procedures under NEPA often point out the need for more extensive environmental studies, namely the preparation of environmental impact statements. In selecting alternative project designs, the Corps strives to choose options with minimum environmental impact.

Under Section 1135 of the Water Resources Development Act of 1986, the Corps is authorized to modify its existing projects—many of them built before current environmental requirements were in effect for environmental improvement. Proposed modifications under this authority range from use of dredged material to create nesting sites for waterfowl to modification of water control structures to improve downstream water quality for fisheries. Several of these proposals were specifically designed to help meet the goals of the North American Waterfowl Management Plan. The Corps is working to select additional projects for modification.



A beaver pipe allows water to pass underneath a beaver dam, preventing the flooding of nearby roads and controlling the water level. This beaver pipe was constructed and installed at Surry Mountain Lake Dam in Surry, New Hampshire.

Regulatory Programs

The Corps of Engineers has regulatory authority over any construction or other work in navigable waterways under Section 10 of the Rivers and Harbors Act of 1899, and authority over the discharge of dredged or fill material into the "waters of the United States" a term which includes wetlands and all other aquatic areas under Section 404 of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500, the "Clean Water Act").

The Corps regulatory program is the principal way by which the Federal government protects wetlands and other aquatic environments and ensures the continued navigability of the Nation's waterways. The regulatory program's goal is to ensure protection of the aquatic environment while allowing for environmentally sustainable development.

The standard permit evaluation process includes a public notice with a public comment period and an opportunity for a public hearing before the Corps makes a permit decision. In its evaluation of permit applications, the Corps considers all the relevant factors, including conservation, economics, aesthetics, general environmental concerns, historical values, wetland values, fish and wildlife values, flood damage prevention, land use classifications, navigation, recreation, water supply, water quality, energy needs, food production and the general welfare of the public.

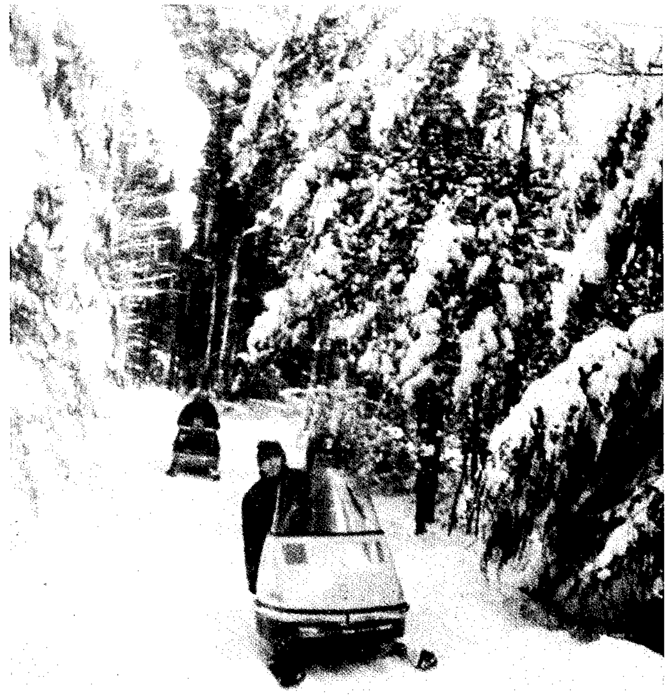
The Corps of Engineers has issued a number of nationwide general permits for minor activities which require little or no individual review. Individual Corps districts have also issued regional permits for certain types of minor work in specific areas. Corps districts have also issued State Program General Permits in States with comprehensive wetland protection programs. These permits allow applicants to do work for which a State permit has been issued. These general permits reduce delays and paperwork for applicants and allow the Corps to devote its resources to the most significant cases while maintaining the environmental safeguards of the Clean Water Act.

Baker Cove in Groton, Connecticut, like many wetlands, supports numerous plant and animal species. Before building a proposed project in a given area, the Corps looks closely at the effects such a project may have on the environment and surrounding wetlands. The Corps considers all options, including those that preclude development, in finding a solution to a water resources problem.

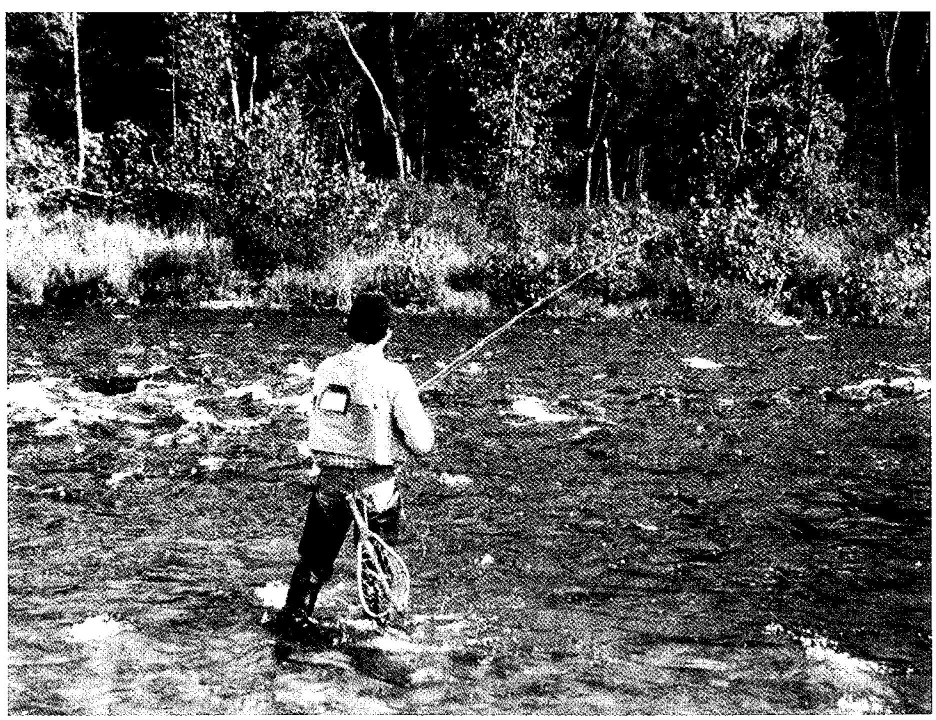
Recreation

The Flood Control Act of 1944, as amended, provides authority to construct, maintain, and operate public park and recreational facilities at water resources development projects under the control of the Secretary of the Army and to permit the construction, maintenance, and operation of such facilities. It also provides that the water areas of projects shall be open to public use - generally for boating, fishing, and other recreational purposes. The Corps of Engineers today is one of the Federal government's largest providers of outdoor recreational opportunities, operating more than 2,000 sites at its lakes and other water resource projects, and receiving more than 600 million visits per year.

The recreation opportunities attract 7.9 million visitors to New England Division projects per year. Of these, 3.9 million visitors utilize the flood control projects, while 4.0 million take advantage of various facilities of the Cape Cod Canal.



There are many recreational opportunities available at the 35 dams and reservoirs built by the Corps' New England Division such as snowmobiling at Blackwater Dam in Webster, New Hampshire (right); and fly fishing at Townshend Lake Dam in Townshend, Vermont (below).



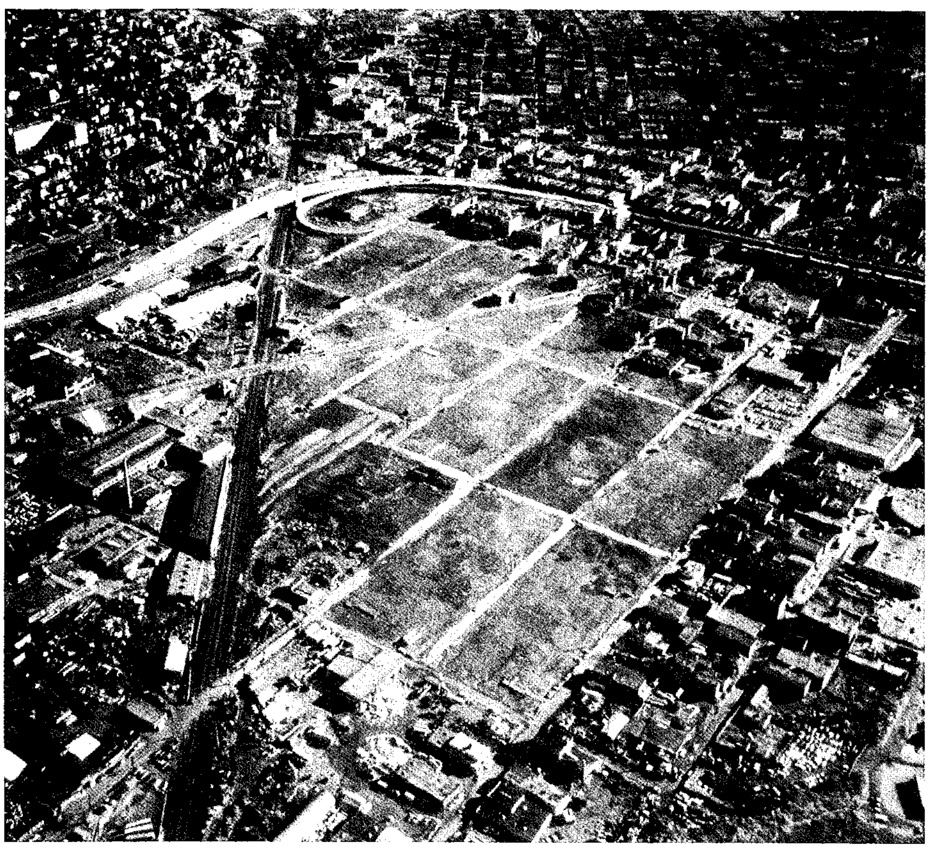
Emergency Response and Recovery

Corps assistance for emergency/disaster response and recovery is provided under Public Law 84-99, covering Flood Control and Coastal Emergencies, or in support of other agencies, particularly the Federal Emergency Management Agency (FEMA) under Public Law 93-288 (the Stafford Act), as amended.

Under PL 84-99 the Chief of Engineers, acting for the Secretary of the Army, is authorized to undertake activities including disaster preparedness, advance measures, emergency operations (e.g., flood fighting, rescue and emergency relief activities), rehabilitation of flood control works threatened or destroyed by flood, protection or repair of Federally authorized shore protection works threatened or damaged by coastal storms, and providing emergency supplies of clean water in cases of drought or contaminated water supply. In post-flood response activities, the Corps provides temporary construction and repairs to essential public utilities and facilities and emergency access for a 10-day period, at the request of the Governor.

Under the Stafford Act and the Federal Disaster Response Plan, the Corps of Engineers has a standing mission assignment to provide public works and engineering support in response to a major disaster or catastrophic earthquake. Under this Plan, the Corps will work directly with the State in providing temporary repair and construction of roads, bridges, and utilities, temporary shelter, debris removal and demolition, water supply, etc.

In addition to its mission under the federal Disaster Response Plan, the Corps is one of the Federal agencies tasked by FEMA to provide engineering, design, construction and contract management in support of recovery operations.



The Corps provided disaster relief assistance to residents of Chelsea, Massachusetts, when fire destroyed 18 city blocks in October 1973.

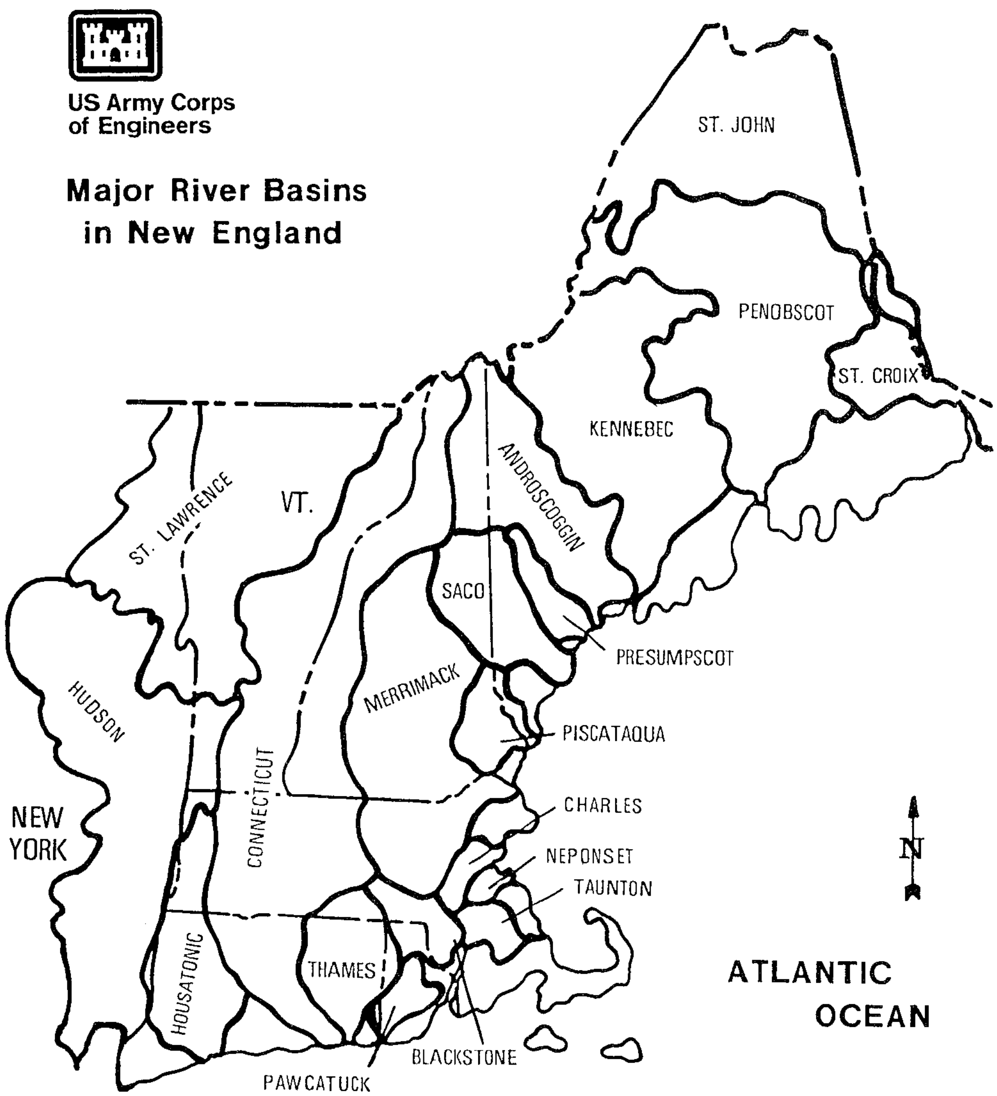
DESCRIPTION OF PROJECTS

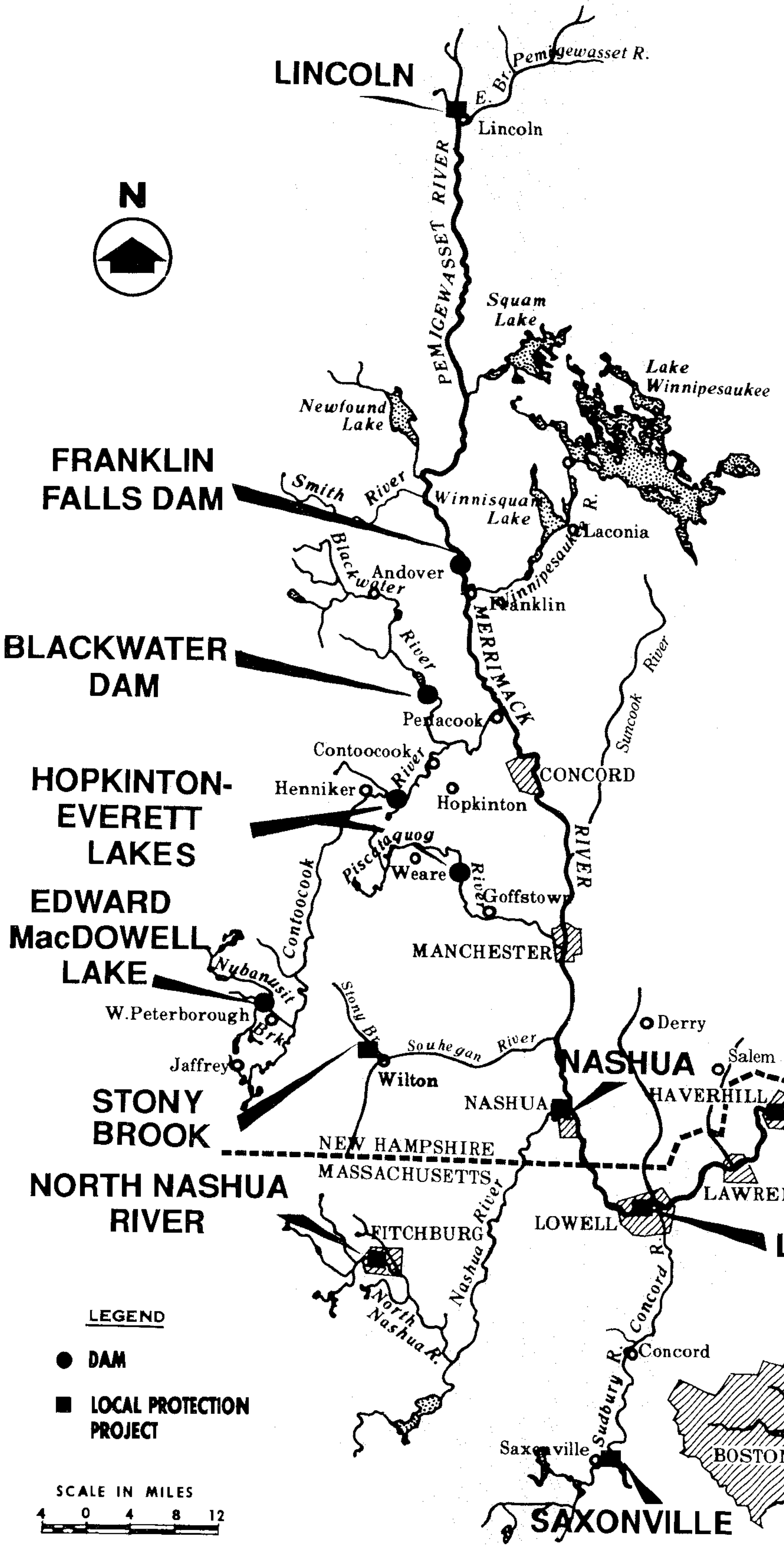
River Basins

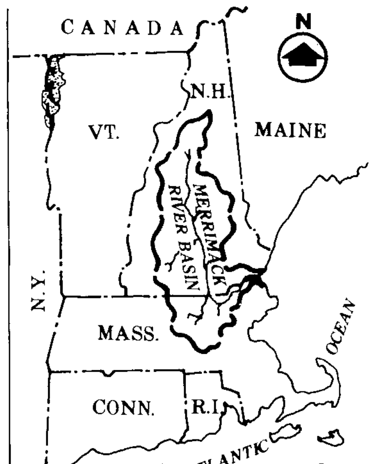
Flooding may be caused by a combination of many factors related to the underlying river basin. Corps' Flood Damage Reduction projects, such as dams and Local Protection Projects, are designed and constructed as part of an overall plan to limit flooding in a particular river basin.

There are 19 principal river basins that lie entirely or partially in New England. Of this number, five lie in New Hampshire—the Connecticut, Merrimack, Androscoggin, Saco, and Piscataqua. Three of these basins—the Connecticut, Merrimack, and Piscataqua—have Corps' Flood Damage Reduction projects within their drainage areas. New Hampshire's 9304 square miles ranks third in New England, behind Maine's 33,215 and Vermont's 9609.

The following pages show where the five river basins lie in the state. Maps of the Connecticut, Merrimack, and Piscataqua River Basins show the location of Corps' Flood Damage Reduction projects in each.



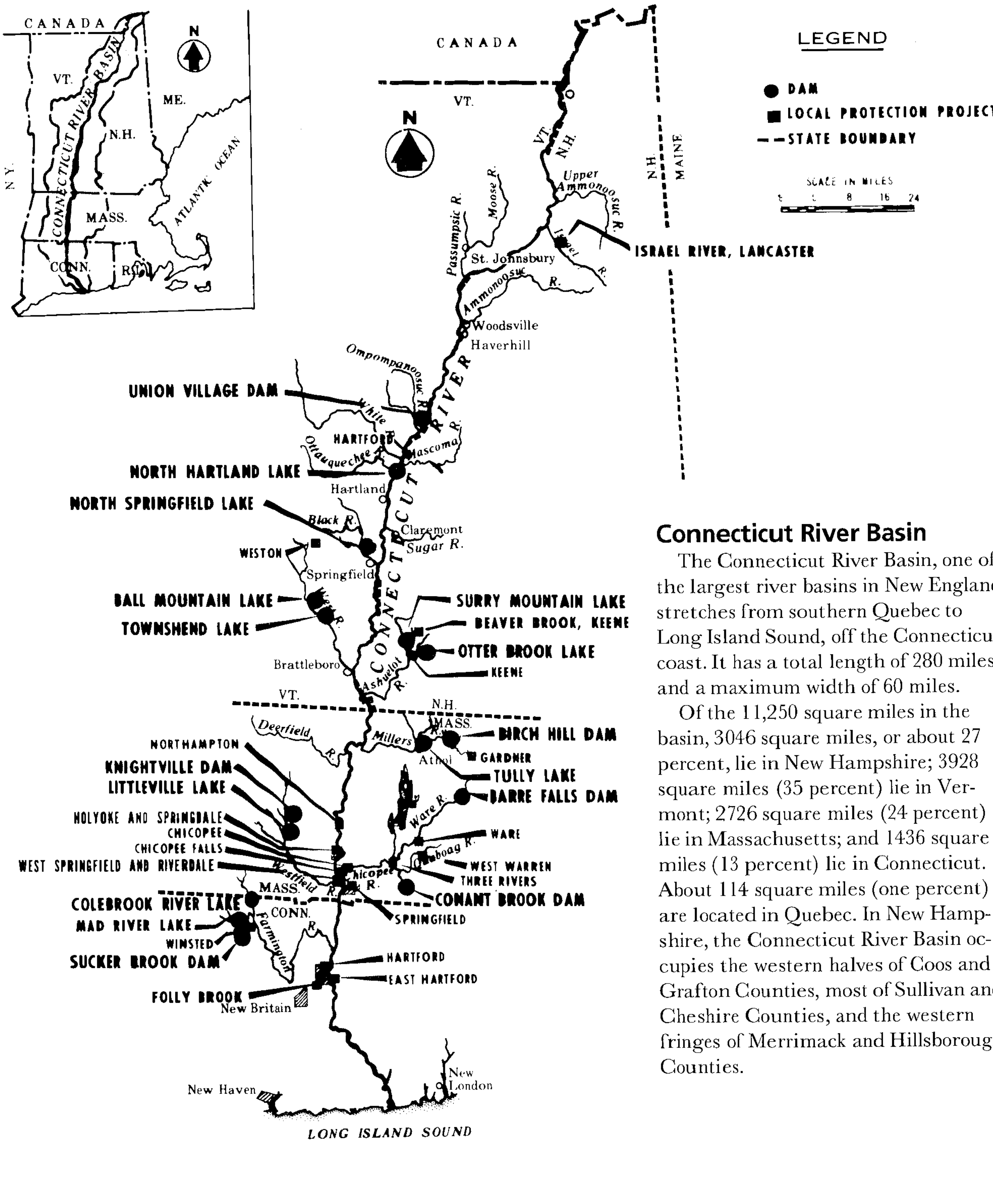




Merrimack River Basin

The Merrimack River Basin extends from the rugged White Mountain region of northern New Hampshire to southeastern Massachusetts. It has a maximum length of 134 miles and a maximum width of 68 miles.

The basin's 5010 square miles make it the fourth largest river basin in New England. About 3810 square miles (76 percent) lie in New Hampshire, and 1200 square miles (24 percent) lie in Massachusetts. The Merrimack River Basin covers parts of every county (except Coos) in New Hampshire, including all of Hillsborough County, most of Merrimack County, the northwestern half of Belknap County, and the western half of Rockingham County.



Connecticut River Basin

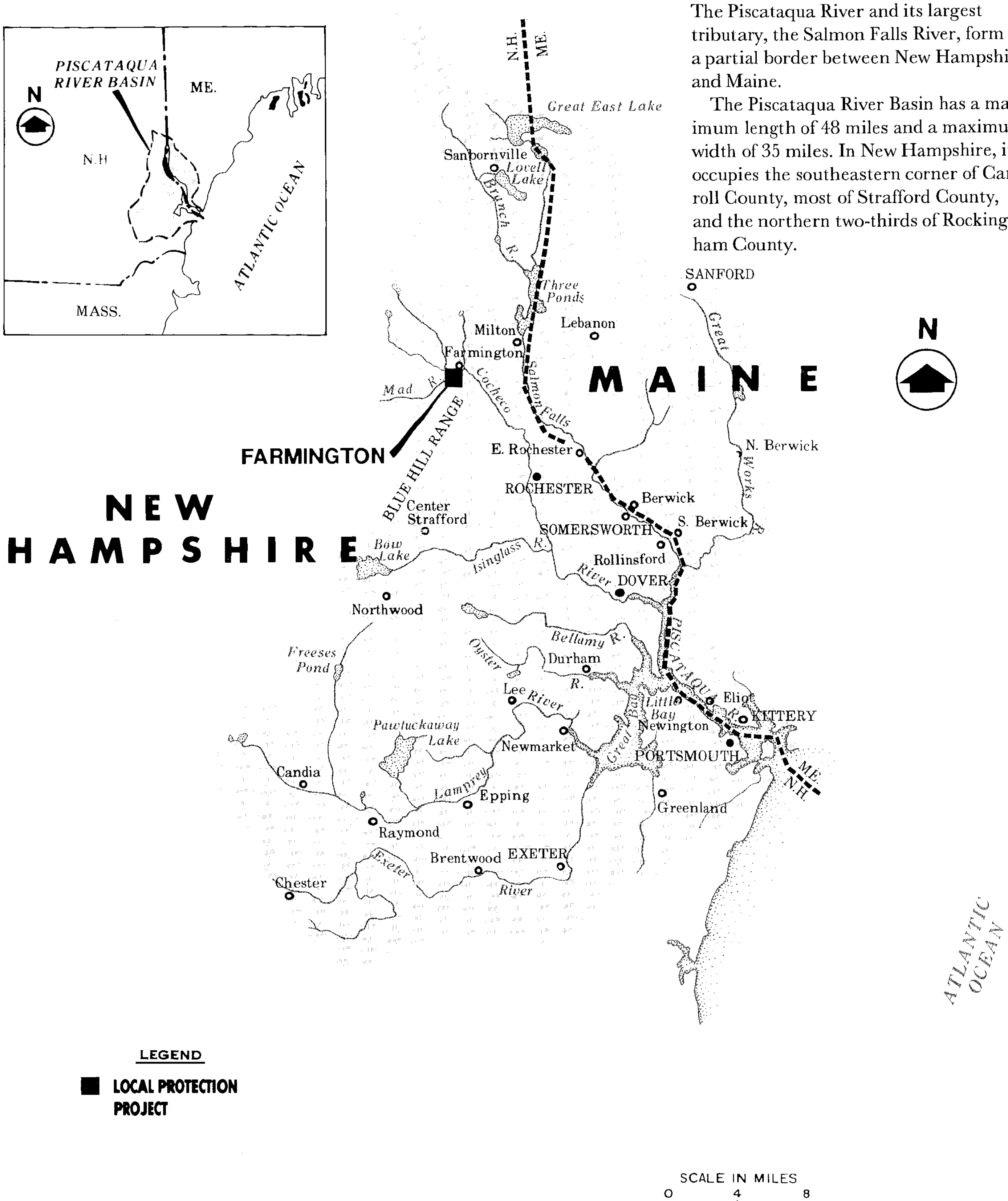
The Connecticut River Basin, one of the largest river basins in New England, stretches from southern Quebec to Long Island Sound, off the Connecticut coast. It has a total length of 280 miles and a maximum width of 60 miles.

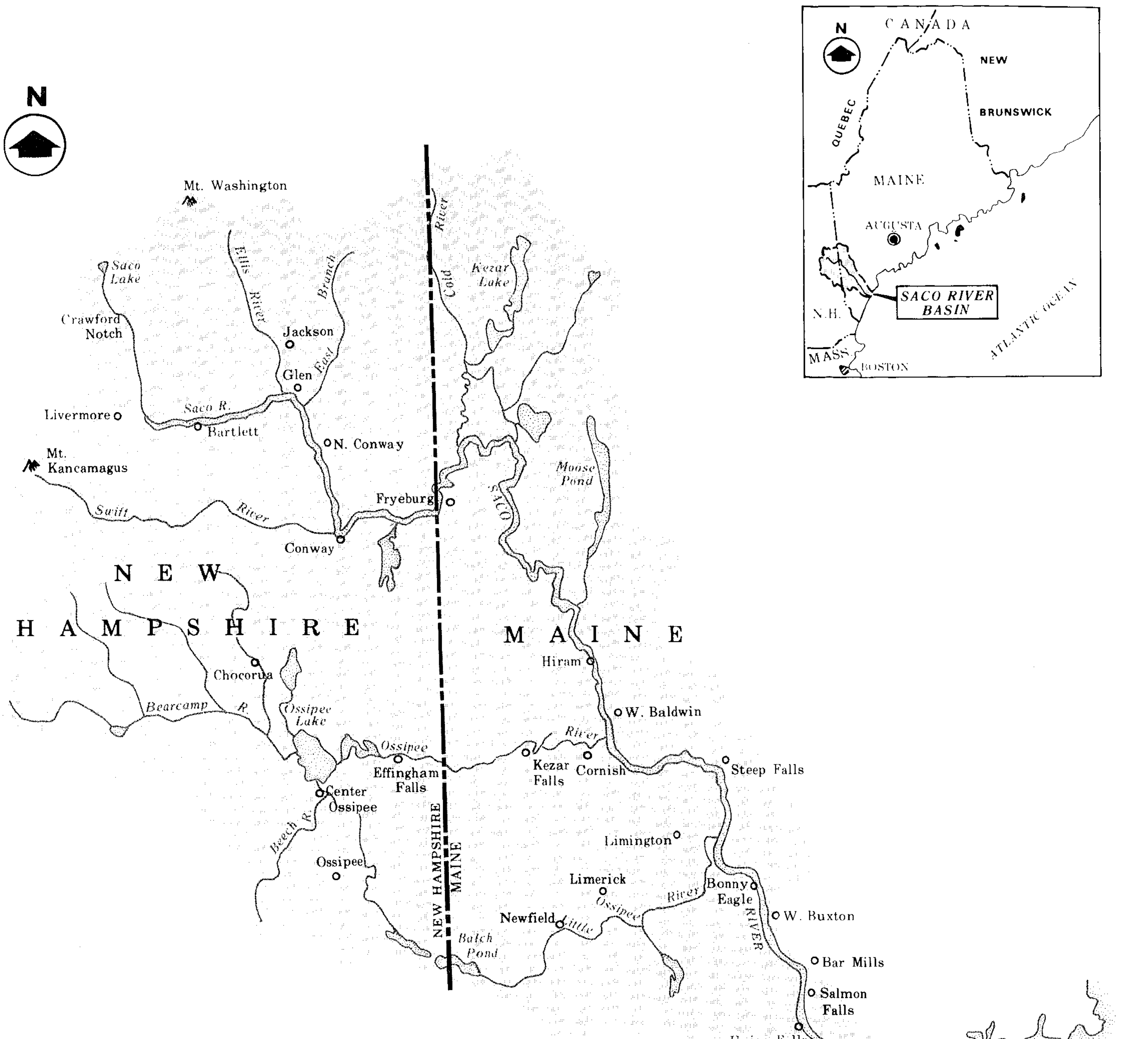
Of the 11,250 square miles in the basin, 3046 square miles, or about 27 percent, lie in New Hampshire; 3928 square miles (35 percent) lie in Vermont; 2726 square miles (24 percent) lie in Massachusetts; and 1436 square miles (13 percent) lie in Connecticut. About 114 square miles (one percent) are located in Quebec. In New Hampshire, the Connecticut River Basin occupies the western halves of Coos and Grafton Counties, most of Sullivan and Cheshire Counties, and the western fringes of Merrimack and Hillsborough Counties.

Piscataqua River Basin

The Piscataqua River Basin lies mostly in southeastern New Hampshire, with a portion lying at the southern tip of Maine. Of the basin's total area of 1022 square miles, 776 square miles (76 percent) lie in New Hampshire and 246 square miles (24 percent) lie in Maine. The Piscataqua River and its largest tributary, the Salmon Falls River, form a partial border between New Hampshire and Maine.

The Piscataqua River Basin has a maximum length of 48 miles and a maximum width of 35 miles. In New Hampshire, it occupies the southeastern corner of Carroll County, most of Strafford County, and the northern two-thirds of Rockingham County.

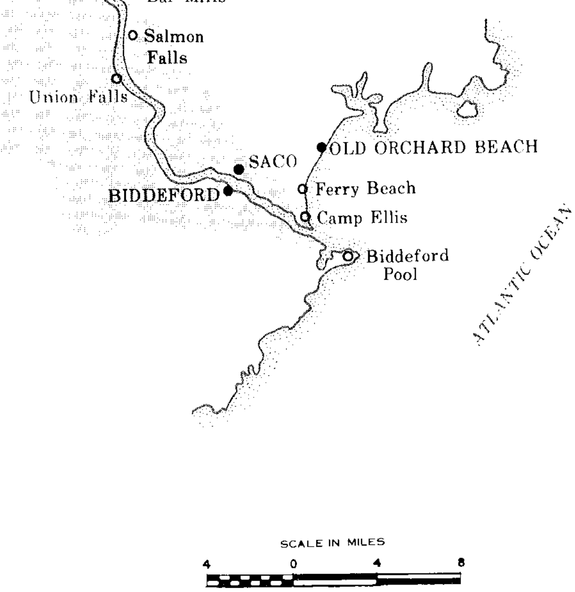


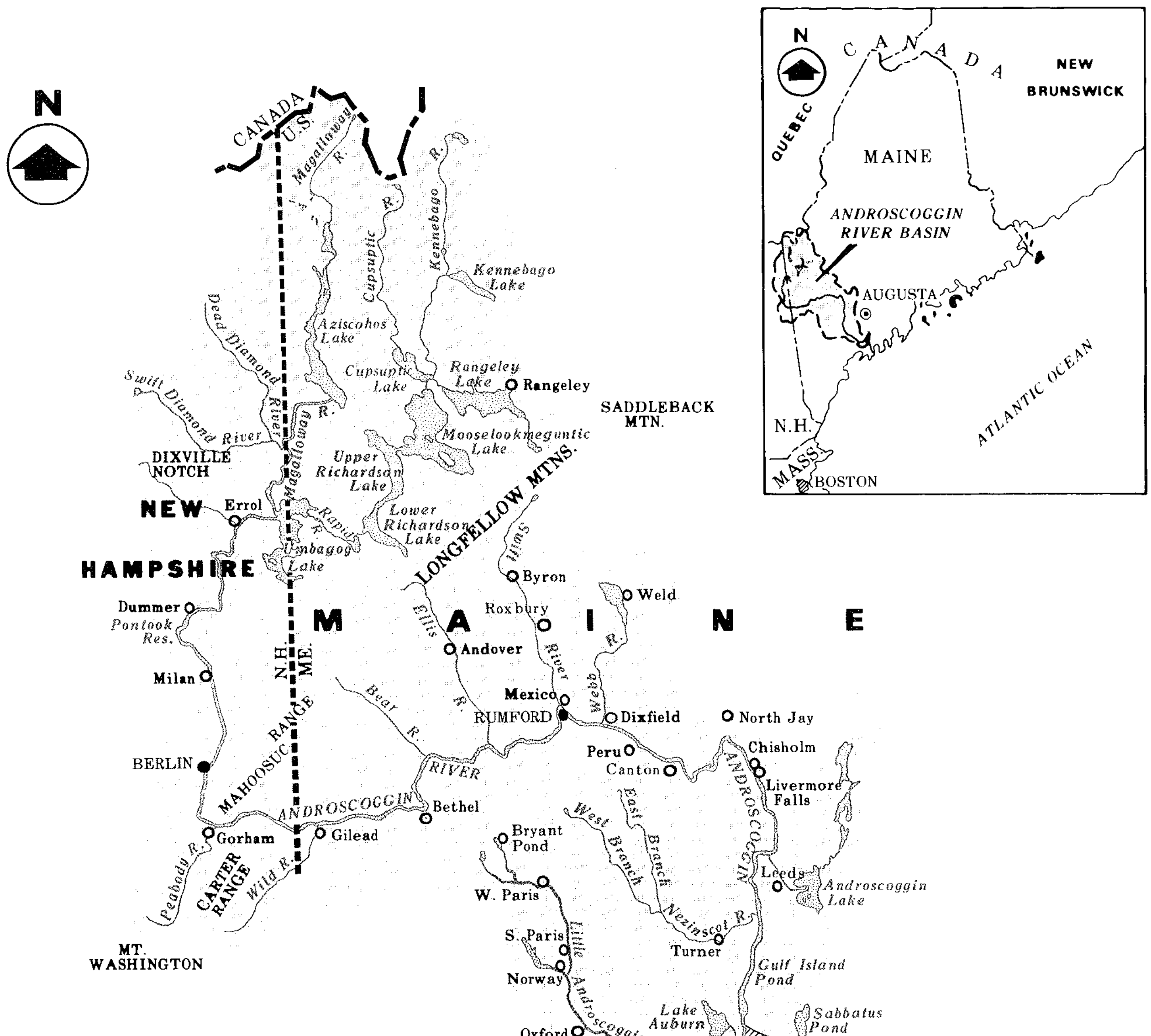


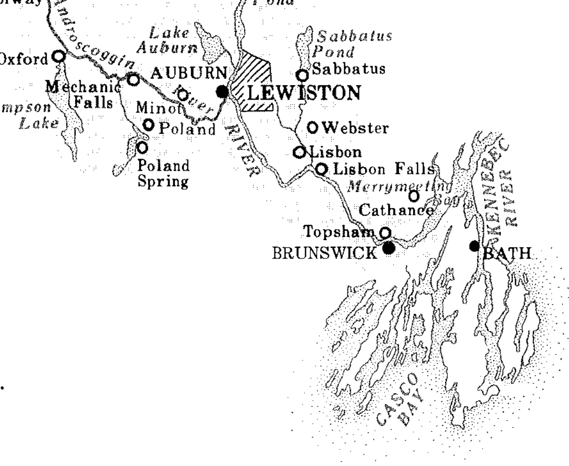
Saco River Basin

The Saco River Basin stretches from eastern New Hampshire into southern Maine. It covers an area of 1697 square miles, of which 870 square miles (51 percent) lie in New Hampshire and 827 square miles (49 percent) in Maine. The basin has a length of nearly 75 miles and a maximum width of 44 miles.

In New Hampshire, the basin occupies nearly all of Carroll County, the northeastern section of Grafton County, and small sections of southeastern Coos County.







Androscoggin River Basin

The Androscoggin River Basin, which lies partly in northeastern New Hampshire and partly in western Maine, begins at the Canadian border and stretches to the Atlantic Ocean. It occupies 3450 square miles, with 2730 square miles (79 percent) lying in Maine and 720 square miles (19 percent) in New Hampshire.

The basin has a maximum length of 110 miles and a maximum width of 65 miles. In New Hampshire, the Androscoggin River Basin covers nearly half of Coos County.

SCALE IN MILES

4 0 4 8 12

Flood Damage Reduction

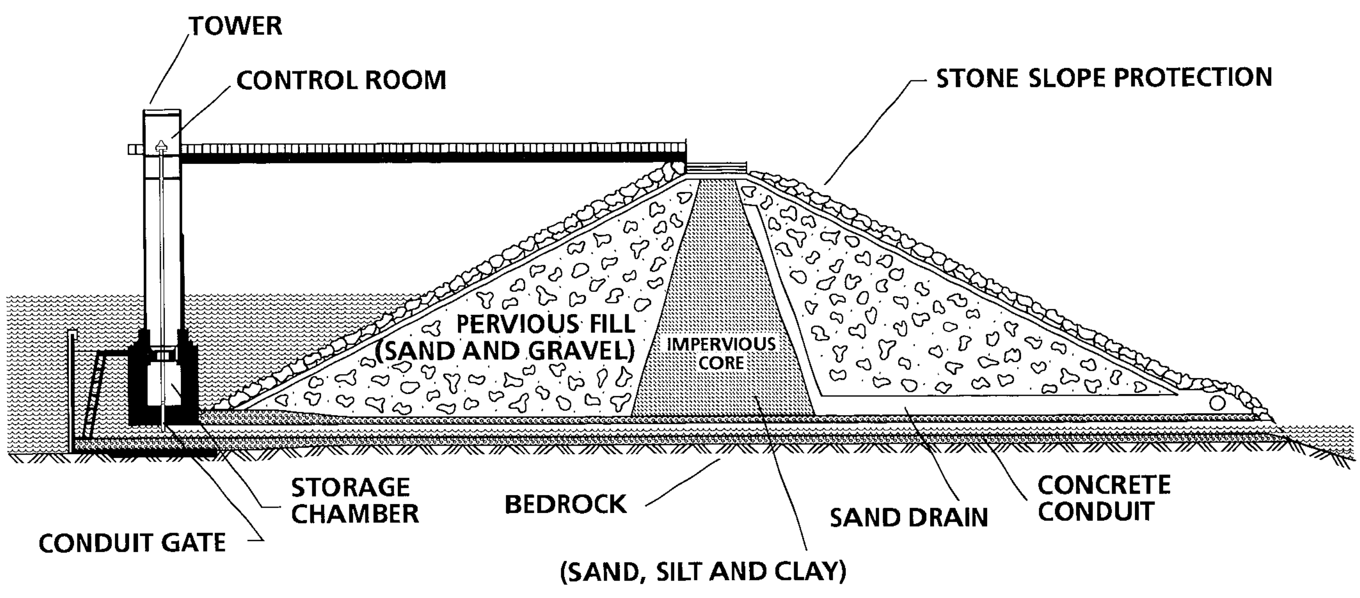
The U.S. Army Corps of Engineers has constructed 13 flood damage reduction projects in New Hampshire that significantly reduce flooding and associated damages.

The seven Corps-built dams (including the two dams built at the Hopkinton-Everett Lakes project) protect wide regions of the state. Costing an aggregate $39.9 million to construct, they have prevented flood damages estimated at $200 million while also offering the public a variety of recreational opportunities and enhancing the environment.

The Corps has also completed seven other flood damage reduction projects in New Hampshire at a cost of $3.7 million. These works are more commonly referred to as local protection projects because they provide flood protection to specific communities rather than wide areas of a state. In New Hampshire, they have prevented an estimated $1.9 million in flood damages. Local protection projects are operated and maintained by the respective municipalities, except for the Israel River project in Lancaster, which is operated by the town but maintained by the Corps of Engineers.

The following pages give a brief history and description of the flood damage reduction projects constructed by the Corps in New Hampshire.

Note: Figures given for damages prevented by each flood control project are estimated through September 1990.



TYPICAL CROSS SECTION OF AN EARTHFILL DAM

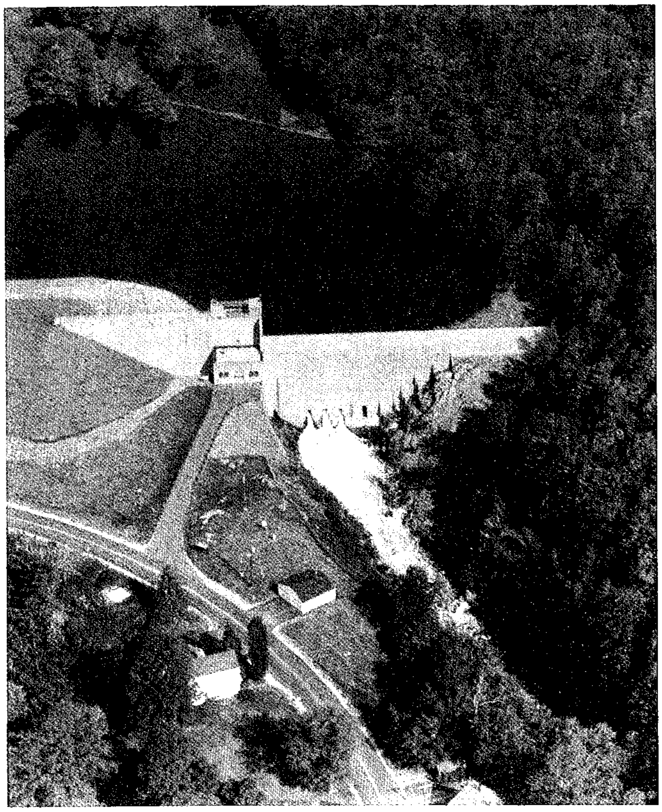
Flood Damage Reduction Projects in New Hampshire

Dams and Reservoirs

Blackwater Dam in Webster
Edward MacDowell Lake in Peterborough
Franklin Falls Dam in Franklin
Hopkinton/Everett Lakes in Hopkinton and Weare
Otter Brook Lake in Keene
Surry Mountain Lake in Surry

Local Protection Projects

Beaver Brook, Keene
Cocheco River, Farmington
Israel River, Lancaster
Keene
Lincoln
Nashua
Stony Brook, Wilton



Blackwater Dam

Blackwater Dam

Blackwater Dam in Webster is located on the Blackwater River, about 18 miles northwest of Concord. From Concord, it can be reached by taking U.S. Route 93 to U.S. Route 4 west, then south on Route 127.

Blackwater Dam significantly reduces flooding in the downstream communities on the Blackwater and Contoocook Rivers, including Webster, Hopkinton, and Boscawen. In conjunction with the Franklin Falls Dam and the dams at Hopkinton and Everett Lakes, Blackwater Dam also reduces flooding in the major industrial, commercial, and residential centers on the Merrimack River, including Concord, Manchester, and Nashua, and the Massachusetts cities of Lowell, Lawrence, and Haverhill. Since its completion, Blackwater Dam has prevented an estimated $15.3 million in flood damages, including $6.1 million during the heavy rains of April 1987.

Construction of Blackwater Dam began in May 1940 and was completed in November 1941 at a cost of $1.3 million. The project consists of an earthfill dam with stone slope protection. The dam is 1150 feet long with a maximum height of 75 feet; there are two earthfill dikes with stone slope protection totalling 1650 feet. Little Hill Dike, located about three miles northwest of the dam, is 1230 feet long and has a maximum height of 28 feet; and Dodge Dike, situated about .5 mile west of the dam, is 420 feet long with a maximum height of 20 feet. There are three gated rectangular conduits. Each conduit measures five feet three inches high, three feet six inches wide, and 65 feet long. A fourth ungated rectangular conduit was permanently plugged in 1951 to increase the effectiveness of the reservoir during flood periods; A spillway is cut in rock with a 240-foot-long concrete weir. The weir's crest elevation is 18 feet lower than the top of the dam. The work included relocating about three miles of Route 127 and constructing smaller roads adjacent to the project.

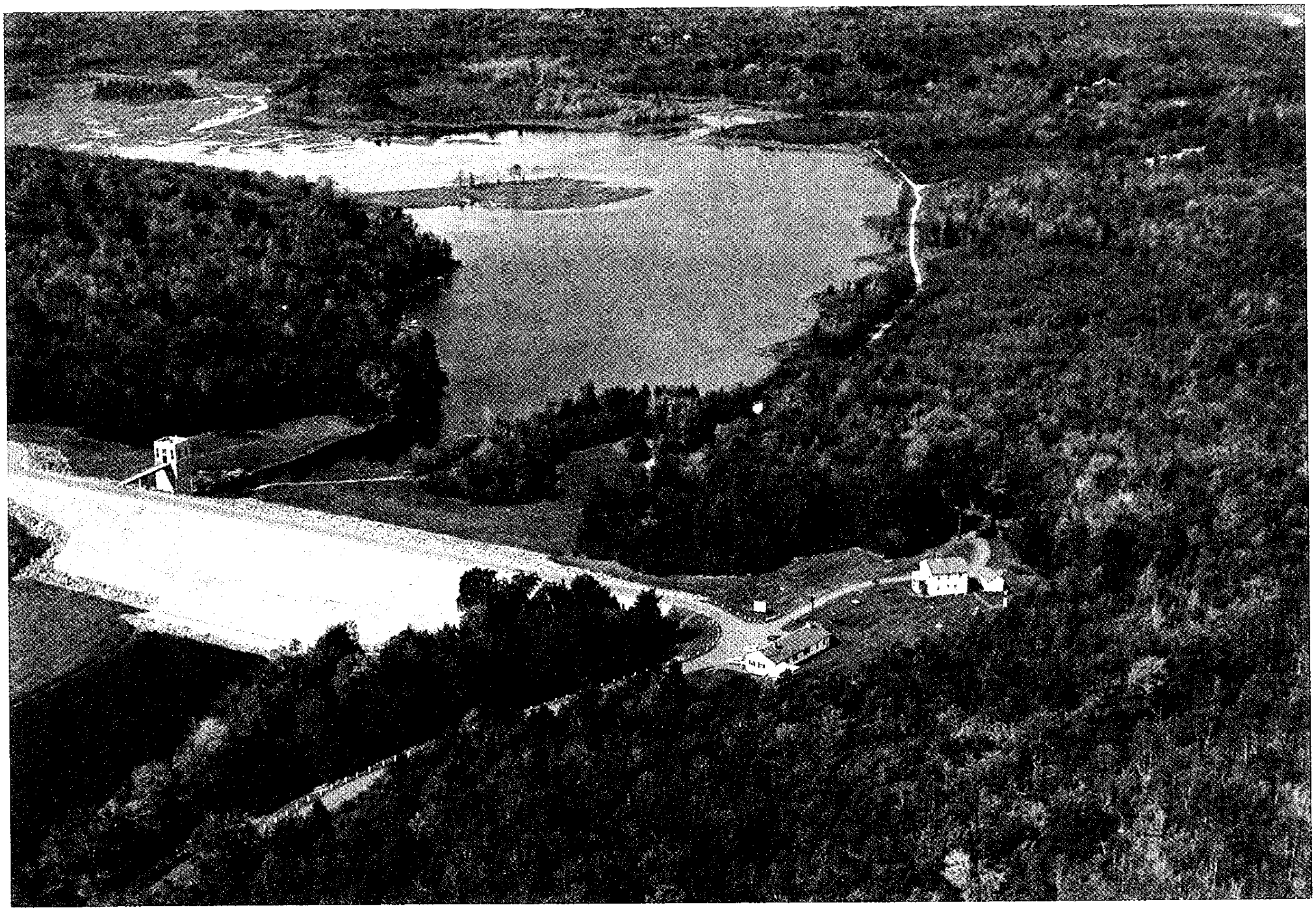
There is no lake at Blackwater Dam. The flood storage area of the project covers approximately 3280 acres and extends upstream about seven miles through Salisbury, having a maximum width of one mile. The entire project, including all associated lands, covers 3580 acres. Blackwater Dam can store up to 15 billion gallons of water for flood control purposes. This is equivalent to 6.7 inches of water covering its drainage area of 128 square miles.

The Corps has issued a license to the New Hampshire Department of Resources and Economic Development to conduct a forestry and fish and wildlife management program on 3475 acres of reservoir lands. A 10-mile section of the Blackwater River meanders through the project area and offers a pristine streamside environment popular with canoeists. Reservoir lands also offer a 19-mile-long snowmobiling trail network that is also used for hiking, horseback riding, and cross-country skiing. The Blackwater River is heavily stocked with rainbow and brown trout by the state and supports self-sustaining brook trout, perch, bass, panfish, and brown bullhead. There is in-season hunting and/or trapping for state-stocked pheasant, as well as black bear, deer, partridge, raccoon, fox, fishercat, and rabbit. Duck hunting is permitted at Greenough Pond, a 40-acre marshy area located within the project area.

Edward MacDowell Lake

The dam at Edward MacDowell Lake is located on Nubanusit Brook in Peterborough, about 14 miles east of Keene. From Nashua, the dam can be reached by taking U.S. Route 3 to Route 101A west (which turns into Route 101) through Peterborough. Continue on Route 101 for about two miles and follow signs to the dam.

Edward MacDowell Lake provides flood protection primarily to Peterborough. The project also provides flood protection to the downstream communities of Hancock, Bennington, Antrim, Deering, Hillsboro, and Henniker, all on the Contoocook River. Since its completion, the dam at Edward MacDowell Lake has prevented an estimated $6.9 million in damages, including $1.8 million during the heavy rains of April 1987, when the flood storage area behind the dam was filled to capacity. During this storm, excess water had to be discharged through the spillway.



Edward McDowell Lake

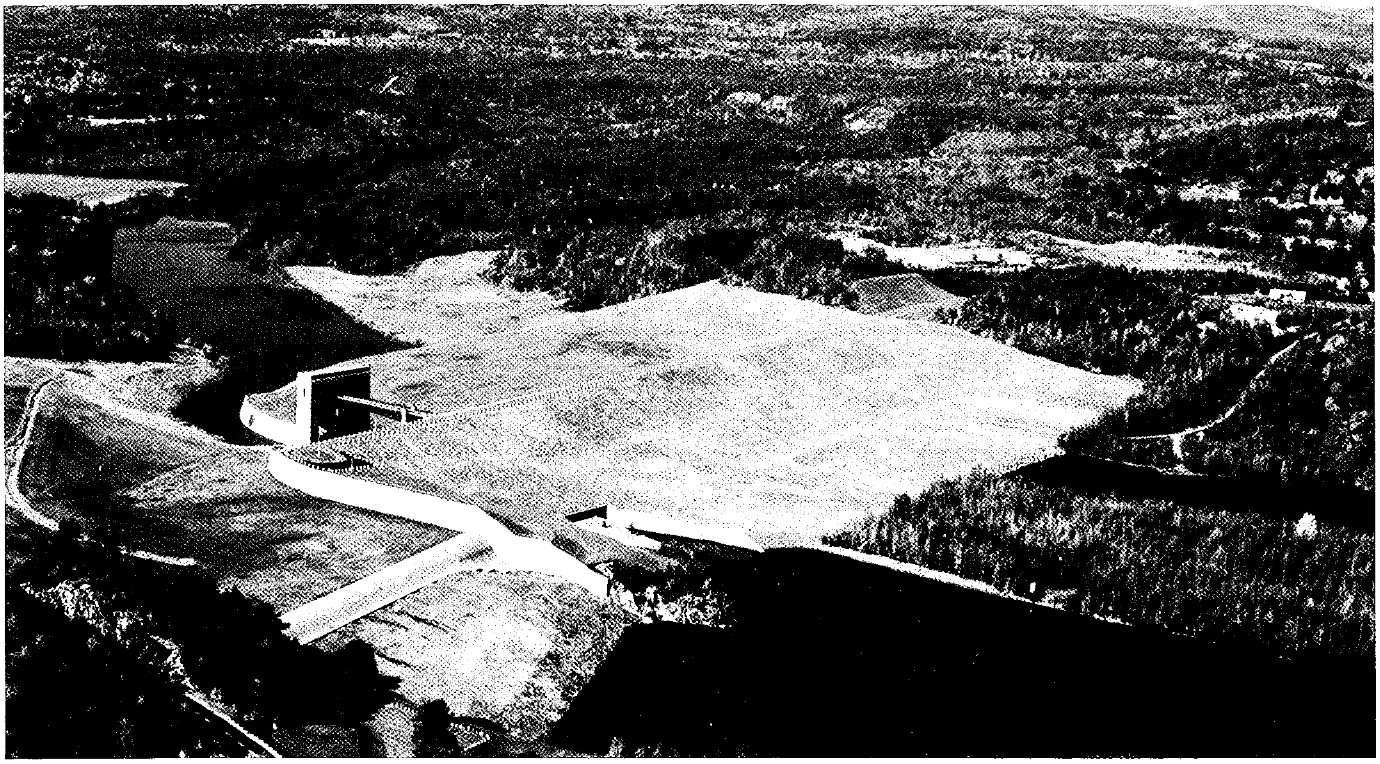
Construction of the dam began in March 1948 and was completed in March 1950 at a cost of $2 million.

Edward MacDowell Lake consists of an earthfill dam with stone slope protection 1100 feet long and 67 feet high; a gated concrete conduit, seven feet high, seven feet wide, and 275 feet long; and a chute spillway cut in rock. The spillway at Edward MacDowell Lake is unusual in that instead of being located adjacent to the dam as most spillways are, it is located 3.2 miles northeast of the dam, at Halfmoon Pond. The spillway has a concrete weir 100 feet long with a crest elevation 21 feet lower than the top of the dam. Discharges from the spillway flow from Halfmoon Pond into Ferguson Brook which, in turn, discharges into the Contoocook River.

There is a conservation pool at Edward MacDowell Lake covering an area of 165 acres and having a maximum depth of about seven feet. The flood storage area of the project totals 840 acres and covers parts of Hancock, Dublin, and Harrisville. The lake and all associated project lands cover 1469 acres. Edward MacDowell Lake can store almost 4.2 billion gallons of water for flood control purposes. This is equivalent to 5.4 inches of water covering its drainage area of 44 square miles.

The Corps operates a small picnic area at the top of the dam with seven picnic tables and 11 fireplaces. However, most of the reservoir lands (1030 acres) are licensed by the Corps to the New Hampshire Department of Fish and Game, which conducts a fish and wildlife management program. Canoes, rowboats, and boats having motors of up to three horsepower are permitted on Edward MacDowell Lake. A stream that winds through Dinsmore Swamp, which is a 600-acre marshy area located on project lands, is particularly popular with canoeists. Project lands also offer trails for hiking and cross-country skiing; snowmobile trails; undeveloped open space for ball playing and other sporting activities; drinking water; and sanitary facilities.

Edward MacDowell Lake is stocked by the state with trout and bass. The three miles of Nubanusit Brook that wind through project lands offer warm water fishing for bass, pickerel, brown bullhead, and perch. Ice fishing is permitted. The state stocks pheasant for hunters, and there is in-season hunting and/or trapping for ruffed grouse, woodcock, beaver, deer, rabbit, fox, raccoon, fishercat, and mink.



Franklin Falls Dam

Franklin Falls Dam

Franklin Falls Dam in Franklin is located on the Pemigewasset River, which joins with the Winnipesaukee River about three miles downstream to form the Merrimack River. From Concord, it can be reached by taking U.S. Route 93 to Route 127 south, or U.S. Route 3 to Route 127 north.

Franklin Falls Dam is a key unit in the comprehensive plan of flood damage reduction for the Merrimack River Basin. It provides flood protection to communities along the entire length of the Merrimack River, including Franklin, Northfield, Boscawen, Canterbury, Concord, and Bow. Along with Blackwater Dam and the dams at Hopkinton and Everett Lakes, Franklin Falls Dam also reduces flooding in the principal industrial and residential centers on the Merrimack River, including Manchester and Nashua and the Massachusetts cities of Lowell, Lawrence, and Haverhill. Since its completion, Franklin Falls Dam has prevented flood damages estimated at $55.1 million.

Construction on the project began in November 1939 and was completed in October 1943 at a cost of $7.9 million. The work involved:

- Relocating a cemetery in Hill;
- Moving several homes on the floodplain in Hill to other locations;
- Demolishing several homes located on the floodplain in Hill; and
- Relocating about nine miles of Route 3A.

The project consists of an earthfill dam with stone slope protection 1740 feet long and 140 feet high; two gated horseshoe conduits, each 19 feet high, 22 feet wide, and 542 feet long; and a chute spillway founded on rock with a concrete weir 546 feet long. The weir's crest elevation is 27 feet below the top of the dam.

Franklin Falls Dam has a permanent pool of 440 acres with a maximum depth of about seven feet. The flood storage area of the project totals 2800 acres. This acreage extends about 12.5 miles upstream through the towns of Hill, Sanbornton, New Hampton, and Bristol, and ends at Ayers Island Dam in Bristol, which is owned by the Public Service Company of New Hampshire. The project and associated lands cover 3683 acres. Franklin Falls Dam can store up to 50.2 billion gallons of water for flood control purposes. This is equivalent to 2.8 inches of water covering its drainage area of 1000 square miles, which represents the largest drainage area upstream of the 35 dams built by the Corps' New England Division.

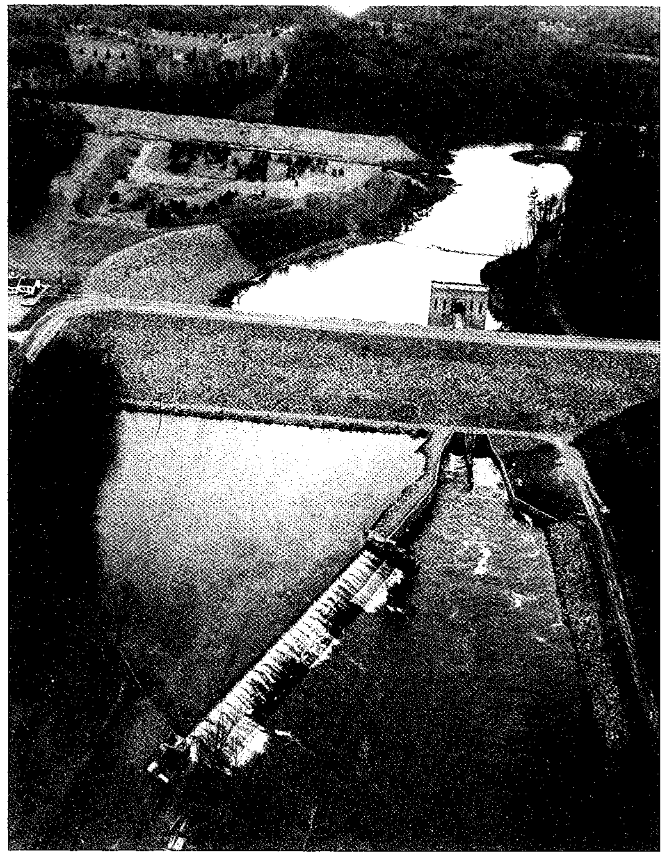
There are two hydroelectric power plants upstream of Franklin Falls Dam, within the reservoir area, that are owned and operated by private interests. One plant, Salmon Brook Station, is situated at the Giles Pond Dam on Salmon Brook in Franklin, approximately .75 mile from Franklin Falls Dam. This facility was built on Corps land and produces 0.2 megawatts of power, which is sold to the Public Service Company of New Hampshire. The second plant, Newfound Hydroelectric, is situated at the Newfound Hydroelectric Dam on the Newfound River in Bristol, approximately 11 miles upstream of Franklin Falls Dam. This facility, which lies on private property but discharges within the Franklin Falls reservoir area, produces 1.5 megawatts of power, which is also sold to the Public Service Company of New Hampshire. A third hydroelectric power facility, Eastman Falls Station in Franklin, is situated at Eastman Falls Dam, about 1.5 miles downstream of Franklin Falls Dam. Situated on private property, Eastman Falls Station is owned by the Public Service Company of New Hampshire. The 440-acre permanent pool behind Franklin Falls Dam is created by the backwaters of the Eastman Falls Dam, which requires this pool to generate power.

The Corps has issued a license to the New Hampshire Department of Resources and Economic Development to conduct a recreation, forestry, and fish and wildlife management program on 3682 acres of reservoir lands. Designated snowmobile trails, also used for hiking, cross-country skiing, and dog sled training, are available within the project. A 12.5-mile section of the Pemigewasset River flows through project lands, offering the public canoeing and other types of boating. The Pemigewasset River also offers cold water fishing and ice fishing for bass, pickerel, perch, brown bullhead, and occasionally salmon. Trout are stocked by the state in the Smith River in Bristol, near scenic Profile Falls, a popular spot with visitors located about eight miles north of the dam. For hunters, the state stocks pheasant and partridge, and in-season hunting and/or trapping is available for deer, raccoon, woodcock, fox, beaver, duck, and occasionally bear.

Hopkinton-Everett Lakes

The dam at Hopkinton Lake, located on the Contoocook River in Hopkinton, and the dam at Everett Lake, located on the Piscataquog River in Weare, are connected by a two-mile-long canal and in moderate to severe flooding are operated as a single flood damage reduction project. From Concord, the dam at Hopkinton Lake can be reached by travelling on U.S. Route 89 north to Route 9 (and 202) west to Route 127 north. From Manchester, the dam at Everett Lake can be reached by taking either Route 114 west through the Riverdale section of Goffstown, then right along River Road for about five miles, or the Everett Turnpike to Route 101 west to Route 114 west to Route 13 north.

The Hopkinton-Everett Lakes project provides flood protection to residential, commercial, and industrial property downstream on the Contoocook and Piscataquog Rivers, which are tributaries of the Merrimack River. Hopkinton Lake protects the communities of Concord (including the Contoocook and Penacook sections), Boscawen, Canterbury, and Bow, while Everett Lake protects Manchester (including the Riverdale section) and Goffstown.



Hopkinton Lake

Operating in conjunction with other Corps dams in the Merrimack River Basin, the project also helps protect major industrial centers along the Merrimack River, including Nashua and the Massachusetts communities of Lowell, Lawrence, and Haverhill. Since their construction, the dams together have prevented an estimated $47.2 million in flood damages. Of this amount, the dam at Hopkinton Lake has prevented $38.3 million, including $18.4 million during the heavy rains of April 1987. The dam at Everett Lake has prevented damages of $8.9 million, including $6.2 million during April 1987.

In November 1927, New England rivers and streams, including the Merrimack River and its tributaries, went on a rampage. The resulting floods claimed several lives and caused serious flood damage. Less than nine years later, in March 1936, the worst flood in three centuries inundated the eastern and central United States. In New England, floodwaters claimed 24 lives, left 77,000 people homeless, and caused damage in New Hampshire and Massachusetts estimated at $36 million ($350 million in today's dollars).

As a result of this devastation, New Hampshire and Massachusetts soon initiated a comprehensive plan to reduce the Merrimack River Basin's disastrous flooding potential. In June 1938, Congress approved the construction of the Hopkinton-Everett dams as part of a coordinated system of flood control for the basin. When completed, the

Hopkinton-Everett Dams would provide assurance that the horrors of the 1927 and 1936 floodwaters would not ravage communities in central and southern New Hampshire and northern Massachusetts. In September 1938, barely three months after Congress approved the project, the basin again suffered crippling flood losses when the most powerful hurricane ever to hit the region slammed into the northeast, overflowing riverbanks and causing widespread destruction. This storm served as a reminder that devastating floods could strike at any time and wreak havoc with lives and property.

Despite all good intentions, roadblocks soon appeared. One major problem revolved around reimbursement from Massachusetts to New Hampshire to compensate for the economic losses New Hampshire would incur by storing floodwaters behind the proposed dams.

It wasn't until 1957 that the state legislatures of New Hampshire and Massachusetts established the Merrimack River Valley Flood Control Commission, which cleared these roadblocks and smoothed the way for the project's construction. An interstate compact was approved and the Corps initiated design studies. Construction of the dams began in November 1959 and was completed in December 1962 at a cost of $21.5 million. The work included relocating portions of Routes 9, 202, 114, and 127; utilities; an abandoned railroad; and four cemeteries.

Hopkinton Lake consists of an earthfill dam with stone slope protection 790 feet long and 76 feet high; three gated square concrete conduits, each measuring 11 feet high and 11 feet wide, with two conduits 124 feet long and the third 128 feet long; and a spillway excavated in rock. The spillway at Hopkinton Lake is unusual in that instead of being located adjacent to the dam as most spillways are, it is located about 1.8 miles east of the dam. The spillway, situated across Cressy Brook, has a concrete weir 300 feet long with a crest elevation 21 feet lower than the top of the dam. Everett Lake consists of an earthfill dam with stone slope protection 2000 feet long and 115 feet high; a gated circular concrete conduit eight feet in diameter and 350 feet long; and a spillway excavated in rock with a concrete weir 175 feet long. The weir's crest elevation is 17 feet lower than the top of the dam.

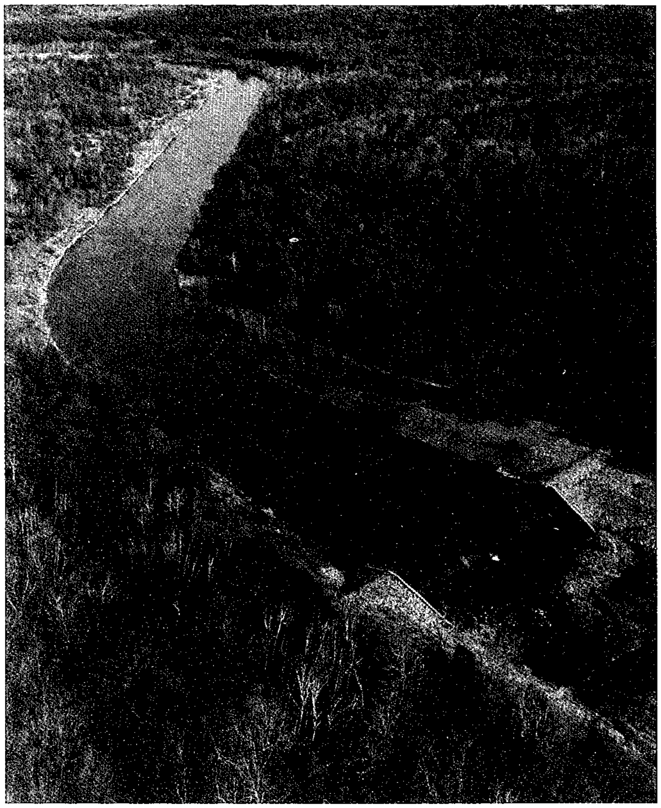
The project also has four earthfill dikes with stone slope protection (two at each dam) totalling 16,300 feet in length. At Hopkinton Lake, Dike One is located on Elm Brook, about .25 mile east of the dam, and is 5220 feet long with a maximum height of 66 feet. Dike Two, located adjacent to the spillway across Cressy's Brook about 1.8 miles east of the dam, has a length of 4400 feet and a maximum height of 67 feet. At Everett Lake, Dike Three, located on Stark Brook about five miles north of the dam near the intersection of Routes 13 and Winslow Road, is 4050 feet long with a maximum height of 50 feet. Dike Four, located on Route 77 about five miles north of the dam and .5 mile west of Dike Three, is 2630 feet long with a maximum height of 30 feet.

The features that distinguish the dams at the Hopkinton-Everett Lakes project from other Corps-built dams in New England are two canals that act in conjunction to divert the floodwaters of the Contoocook River stored behind the dam at Hopkinton Lake to the flood storage area behind the dam at Everett Lake. During minor and moderate flooding, there is enough flood storage area behind the dam at Hopkinton Lake to store the floodwaters from the Contoocook River, and there is enough storage area behind the dam at Everett Lake to hold back floodwaters from the Piscataquog River. However, when major flooding occurs, there is not enough land behind the dam at Hopkinton Lake to hold the large volume of floodwaters from the Contoocook River. If not held back, these floodwaters would race downstream and threaten lives and property. There is, however, enough land behind the dam at Everett Lake on the Piscataquog River to hold not only potentially damaging floodwaters from the Piscataquog River, but also the excessive floodwaters from the Contoocook River that the dam at Hopkinton Lake cannot contain. The two canals act together to direct Contoocook River floodwaters from behind the dam at Hopkinton Lake to the flood storage area behind the dam at Everett Lake.

Canal I is located about .25 mile upstream of the dam at Hopkinton Lake and diverts water from the Contoocook River into Elm Brook Pool, situated behind the dam. The earthen canal is lined with rock and is approximately 4000 feet long and 120 feet wide. Canal II is situated roughly halfway between the two dams; it is this canal that connects the flood storage area behind the dam at Hopkinton Lake with the flood storage area behind the dam at Everett Lake, allowing the two dams to function as a single unit. This canal has a total length of 10,400 feet (about two miles), of which 8400 feet was cut in earth with a width of 160 feet. The upper 2000 feet of the canal is Drew Lake, a natural body of water with a width roughly the same as the rest of the canal. During major flooding, floodwaters pass from the Contoocook River to Canal I to Elm Brook Pool, then pass into Canal II to Everett Lake.

Most flooding on the Contoocook River is either minor or moderate and does not require the transfer of excessive floodwaters through the canals. Since the project's completion in December 1962, the diversion of Contoocook River floodwaters from behind the dam at Hopkinton Lake to the flood storage area behind the dam at Everett Lake has occurred only seven times, the last in April 1987 when the combined reservoir area of the two dams was filled to 95 percent of capacity, its highest level ever.

The flood storage area behind Hopkinton Lake totals 3700 acres and extends about 8.5 miles upstream through Henniker to the Contoocook Valley Paper Company. This acreage includes areas that are normally empty and areas that have permanent bodies of water. Some of the larger bodies of water behind the dam at Hopkinton Lake include the 220-acre permanent pool on the Contoocook River, which has a maximum depth of 14 feet; the 456-acre Elm

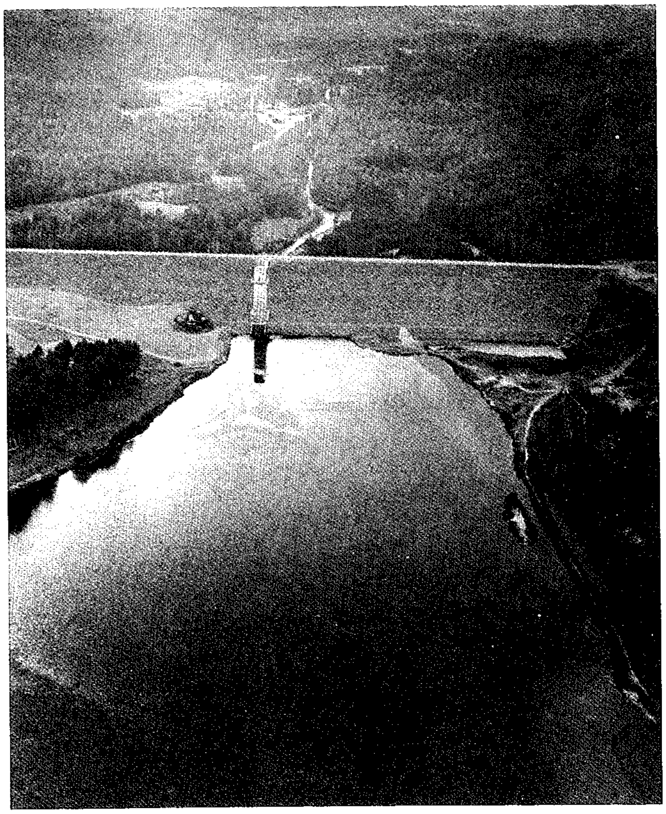



Canal II (both photos) connects the flood storage area behind the dam at Hopkinton Lake with the flood storage area behind the dam at Everett Lake, allowing the dams to function as a single unit. Canal II is a 10,400-foot-long strait, of which the upper 2000 feet is Drew Lake (above left). Floodwaters pass from Elm Brook Pool behind the dam at Hopkinton Lake to Drew Lake/ Canal II. These floodwaters then flow down the canal and empty into the flood storage area behind the dam at Everett Lake. The photo (above right) shows the end of Canal II as it empties into the Everett Lake flood storage area.

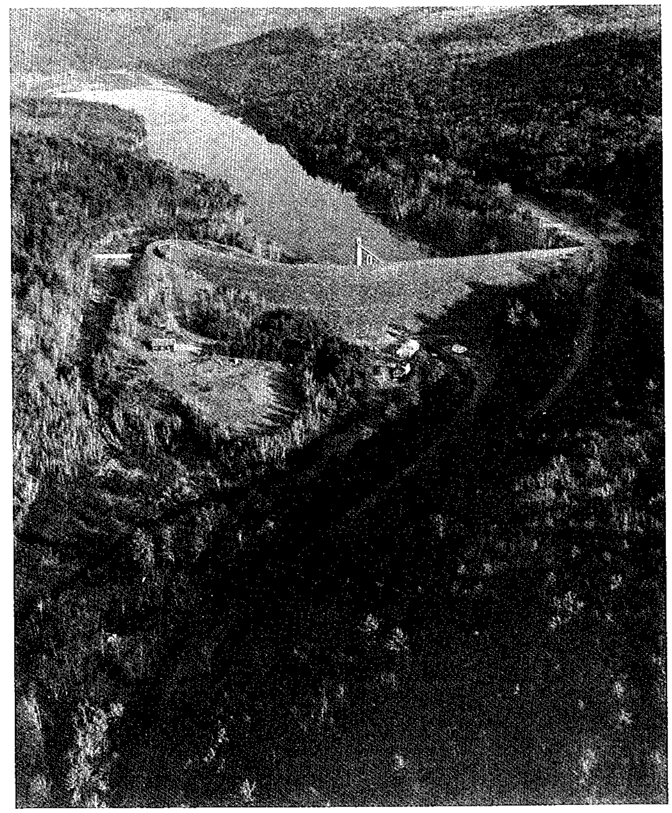
Brook Pool; the 47-acre Drew Lake, which makes up the upper 2000 feet of Canal II; and two lakes, approximately 87 and 35 acres respectively, located within the confines of Stumpfield Marsh. The flood storage area behind Everett Lake totals 2900 acres and extends westerly up the Piscataquog River in Weare; northerly up Choate Brook, which lies mostly in Weare with a small portion lying in Dunbarton; and northerly up Stark Brook in Dunbarton. This acreage includes a 130-acre permanent pool with a maximum depth of 15 feet. Together, the flood storage areas behind both dams can hold 52.6 billion gallons of water, which would cover approximately 8000 acres (12.5 square miles). This is equivalent to 6.8 inches of water covering its drainage area of 446 square miles. The lakes and all associated project lands cover 9945 acres.

The Hopkinton-Everett Reservoir area offers the public a wide variety of recreational opportunities. At Hopkinton Lake, the recreational area situated behind the dam, known as Elm Brook Park, offers boating, a boat ramp, and swimming on a 300-foot-long beach. Elm Brook Park also has 130 picnic tables and 62 fireplace grills; four picnic shelters; a .5-mile-long nature trail; horseback riding over several miles of project roads; cross-country skiing; snowmobiling on designated trails; an open field for ball playing and other sporting activities; drinking water; and sanitary facilities. Other recreational activities popular at Elm Brook Park include canine field trials, which test a dog's temperament, skill, and ability for tracking, hunting, and guarding, and the flying of radio-controlled model airplanes.

The Corps has issued a license to the New Hampshire Department of Resources and Economic Development (DRED) to conduct a forestry and fish and wildlife management program on 3282 acres of land at Hopkinton Lake. As a result, Hopkinton Lake offers excellent fishing and hunting opportunities. The various bodies of water behind the dam, including Elm Brook Pool, Drew Lake, and the two bodies of water at Stumpfield Marsh, offer what many consider to be some of the best bass fishing in the state. There is also year-round fishing in these areas for self-sustaining perch, pickerel, and brown bullhead Ice fishing is permitted. Hunters will find state-stocked pheasant, as well as ruffed grouse, quail, duck, and geese. In addition to the good fishing and hunting available at Stumpfield Marsh, this 700-acre area (including approximately 122 acres of water and 578 acres of woodlands) provides a waterfowl nesting area for species such as wood duck, mallard, hooded merganser, and black duck. One of the few blue heron rookeries in the state is located in Stumpfield



Everett Lake



Otter Brook Lake

Marsh, which lies undisturbed, as it was before the Hopkinton-Everett Dams were built.

Stumpfield Marsh is part of the land that is licensed by the Corps to DRED, but the marsh area itself is managed in cooperation with the Fish and Game Department. The Corps also leases about 13 acres of land at Hopkinton Lake to New England College in Henniker for baseball, football, soccer, field hockey, and outdoor basketball.

At Everett Lake, the Corps has issued a license to DRED to conduct a forestry and fish and wildlife management program on 2957 acres of land. Another 50 acres of land are leased to DRED to operate Clough State Park, which offers 110 wooden and 60 concrete picnic tables; two picnic shelters; about 80 fireplace grills; swimming on 900 feet of beach; boating for canoes, sailboats, and rowboats (boats with motors are prohibited); a boat ramp; an open field for ball playing and other sporting activities; drinking water; and sanitary facilities. About 15-20 miles of old roads at Everett Lake, including old Route 77, Bassett Mill Road, and the lower end of Sugar Hill Road, provide cross-country skiing trails and designated trails for snowmobiling.

Everett Lake offers good year-round fishing for self-sustaining bass, pickerel, and brown bullhead. The state stocks brook, brown, and rainbow trout in the Piscataquog River, which empties into Everett Lake. The 19-acre Stark Pond Waterfowl Marsh Area, which lies on reservoir lands and is managed by DRED, offers fishing for self-sustaining perch, pickerel, and brown bullhead. There is in-season hunting for state-stocked pheasant, as well as ruffed grouse, woodcock, bear, deer, and rabbit.

Otter Brook Lake

The dam at Otter Brook Lake in Keene is located on Otter Brook, a tributary of the Branch River, which in turn is a tributary of the Ashuelot River. From Keene, the project can be reached by travelling two miles east on Route 101 to Branch Road.

In conjunction with Surry Mountain Dam, Otter Brook Lake provides flood protection to Keene, Swanzey, Winchester, and other communities along the Ashuelot River. Along with other Corps dams, Otter Brook Lake helps reduce flooding along the Connecticut River. Since its completion, Otter Brook Lake has prevented damages estimated at $23.9 million, including $3.6 million during the heavy rains of April 1987, when the flood storage area behind the dam was filled to capacity. During this storm, excess water had to be discharged through the spillway.

Construction of the project began in September 1956 and was completed in August 1958 at a cost of $4.4 million. The project consists of an earthfill dam with stone slope protection 1288 feet long and 133 feet high; a gated concrete horseshoe conduit, six feet in diameter and 589 feet long; and a chute spillway founded on rock with a concrete weir 145 feet long. The weir's crest elevation is 21 feet lower than the top of the dam. The work included relocating Branch Road and a portion of Route 9.

Otter Brook Lake contains a 70-acre recreation pool that has a maximum depth of 18 feet. The flood storage area of the project totals 375 acres and extends about 2.3 miles upstream into Roxbury. The lake and all associated project lands cover 582 acres. Otter Brook Lake can store 5.7 billion gallons of water for flood control purposes. This is equivalent to seven inches of water covering its drainage area of 47.2 square miles.

Otter Brook Lake features a popular recreational area one mile north of the dam that is accessible only from Route 9 and is situated about four miles east of Keene. It offers a picnic area with 90 tables and 55 fireplace grills; swimming on a 400-foot-long beach; a change house; boating for canoes, rowboats, sailboats, and boats with electric motors (gas-powered motors are prohibited); a boat ramp; a ball field; snowmobiling; cross-country skiing; drinking water; and sanitary facilities. Otter Brook, both upstream and downstream of the lake, is stocked by the state with brook and rainbow trout, and the lake supports chain pickerel, yellow perch, and bass. Ice fishing is permitted. There is in-season hunting and/or trapping for deer, beaver, muskrat, fisher, and wild turkey.

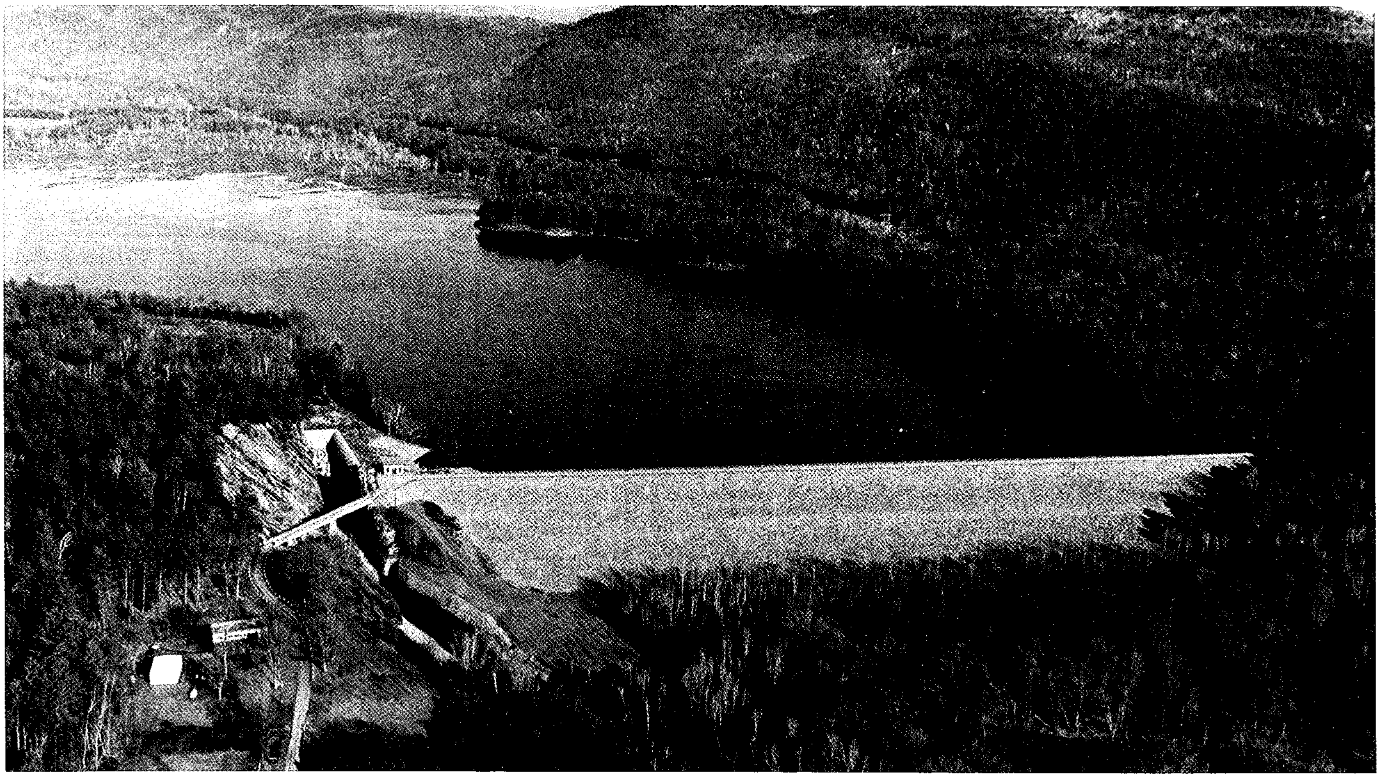
Surry Mountain Lake

The dam at Surry Mountain Lake is located on the Ashuelot River in Surry, about five miles north of downtown Keene and .5 mile north of the Keene-Surry line, on Route 12A.

In conjunction with Otter Brook Lake, Surry Mountain Lake provides flood protection to downstream communities on the Ashuelot River, including Keene, Swanzey, Winchester, and Hinsdale. Along with other Corps dams, Surry Mountain Lake also helps reduce flooding along the Connecticut River. Since its completion, it has prevented damages estimated at $52 million, including $7.9 million during the heavy rains of April 1987, when the flood storage area behind the dam was filled to capacity. During this storm, excess water had to be discharged through the spillway.

Construction on the project began in August 1939 and was completed in October 1941 at a cost of $2.8 million. The project consists of an earthfill dam with stone slope protection 1800 feet long and 86 feet high; a concrete horseshoe conduit 10 feet in diameter and 383 feet long; and an L-shaped spillway excavated in rock with a concrete weir 338 feet long. The weir's crest elevation is 18 feet lower than the top of the dam. The work included relocating a portion of Route 12A and a utility line.

Surry Mountain Lake contains a 260-acre recreation pool with a maximum depth of 15 feet that was established



Surry Mountain Lake

in 1962 at the request of the town. The flood storage area of the project totals 970 acres and extends about five miles upstream. The lake and all associated project lands cover 1779 acres. Surry Mountain Lake can store almost 10.6 billion gallons of water for flood control purposes. This is equivalent to 5.9 inches of water covering its drainage area of 100 square miles.

The Surry Mountain Recreation Area, which is accessible on Route 12A from Keene (about .75 mile north of the dam entrance), offers visitors many recreational opportunities. A large picnic area offers 80 tables and 45 fireplace grills. There is a 600-foot-long sandy beach and swimming area, and a boat ramp is available for those who enjoy canoeing, sailing, and motorboating. The .75-mile-long Beaver Lodge Nature Trail is popular with hikers. Cross-country skiers and snowmobilers enjoy the old abandoned roads and the five acres of open field, which are also used for ball playing and other sporting activities. The recreation area also has a change house, drinking water, and sanitary facilities.

Fishing opportunities abound within the project. Surry Mountain Lake offers self-sustaining largemouth and smallmouth bass, pickerel, brown bullhead, and yellow perch. A section of the Ashuelot River that runs through project lands offers streamside fishing for state-stocked brook and rainbow trout. Ice fishing is permitted. There is in-season hunting and/or trapping for state-stocked pheasant, as well as deer, ruffed grouse, woodcock, wild turkey, raccoon, fox, fisher, beaver, mink, and otter.

Visitors are encouraged to enjoy the panoramic view from atop the dam, which reveals the wide U-shaped valley encompassing Surry Mountain Lake. The scenery is especially spectacular during the foliage season. Wildlife is abundant throughout the project area, and several waterfowl species thrive in the shrub swamp at the upper end of the lake. The project's diverse habitat also supports many species of birds, including the broad-winged hawk, herring gull, osprey, kestrel, and songbirds. Whitetail deer and black bear have also been spotted utilizing their natural environment.

The privately-owned Surry Mountain Campground lies on nonfederal land adjacent to the project area and offers 35 campsites.

LOCAL PROTECTION PROJECTS

Beaver Brook, Keene

Cocheco River, Farmington

Israel River, Lancaster

Keene

Lincoln

Nashua

Stony Brook, Wilton

Completed in 1986, the Beaver Brook project in Keene has already prevented an estimated $1.6 million in flood damages. The project includes a 250-foot-long concrete dam across Three Mile Swamp (center) and a 1100-foot-long dike that runs parallel to Route 10 (left).

Beaver Brook, Keene

The Beaver Brook Local Protection Project in Keene is located on Beaver Brook, a tributary of the Ashuelot River. It is about 42 miles west of Manchester.

The project reduces flood damages to residential, commercial, industrial, and public property along a 3.5-mile-long reach of Beaver Brook. This reach begins at Three-Mile Swamp and flows southerly for 2.5 miles before it enters Keene's business district in the heart of the city. Beaver Brook then flows for about one mile through the business district before joining The Branch, which then flows into the Ashuelot River immediately outside of the downtown area.

Flooding along this 3.5-mile-long reach of Beaver Brook, particularly along the one mile of stream that passes through Keene's business district, has been a recurring problem. The business district, from Water Street to Beaver Brook's confluence with the Ashuelot River, is home to much of the city's commerce and industry and some of Keene's oldest and more densely populated neighborhoods. Since 1927, floodwaters from Beaver Brook have caused extensive damage to this area. Four of the more damaging floods on Beaver Brook in the last 40 years occurred in November 1950, October 1959, April 1960, and December 1973. The worst flooding on record, the hurricane of September 1938, caused damages totalling $1.1 million along the Ashuelot River and its tributaries. Along Beaver Brook, these losses were estimated at $218,000 and included damage to 347 homes, 15 commercial firms, and 10 industrial plants.

The Beaver Brook Local Protection Project was built between May-November 1986. Its construction dramatically demonstrates how a project can prevent damage during unexpected flooding. Only six months after it was completed at a cost of $2.7 million, the project prevented an estimated $1.6 million in flood damages during the heavy rains of April 1987.

The project was built under Section 205 of the Continuing Authorities Program (small projects), and is operated and maintained by Keene. Work on the project consisted of replacing an existing 190-foot-long stone dam located at Three Mile Swamp with a 250-foot-long concrete dam and spillway. Three Mile Swamp is a natural flood storage wetland that is about six feet deep. The concrete dam and spillway is designed so that Three Mile Swamp will maintain its existing water level during non-flood periods and temporarily store floodwaters during periods of heavy rainfall and/or snowmelt. When filled to capacity, floodwaters behind the dam would cover 106 acres, including lowlands that lie adjacent to Three Mile Swamp. The dam does not eliminate flooding on Beaver Brook; instead, it temporarily stores floodwaters in the natural flood storage retention area of Three Mile Swamp and the adjacent lowlands, preventing these floodwaters from racing downstream and posing threats to lives and property, especially in Keene's business district; Constructing a stilling basin immediately downstream of Three Mile Swamp and the adjacent lowlands, preventing these floodwaters from racing downstream and posing threats to lives and property, especially in Keene's business district; Constructing two earthfill dikes totalling approximately 1285 feet. These dikes protect Route 10, situated adjacent to Three Mile Swamp, from flooding when the dam is storing floodwaters in the wetland. Dike A begins at the dam and runs parallel to Route 10. It is approximately 1100 feet long, has a maximum height of 12 feet, and has stone slope protection. Dike B, which runs perpendicular to Route 10, is about 185 feet long and has a maximum height of eight feet; Constructing slope protection in the section of Beaver Brook between Water and Marlboro Streets. The slope protection consists of precast concrete paving blocks (gridblock), and was built on the lower four feet of each bank. Approximately 1480 feet of slope protection was built on the left bank, and approximately 1585 feet was constructed on the right bank; and constructing an 80-foot-long retaining wall on the right bank of Beaver Brook, in the section between Water and Marlboro Streets. The wall consists of precast concrete blocks and has a maximum height of nine feet.

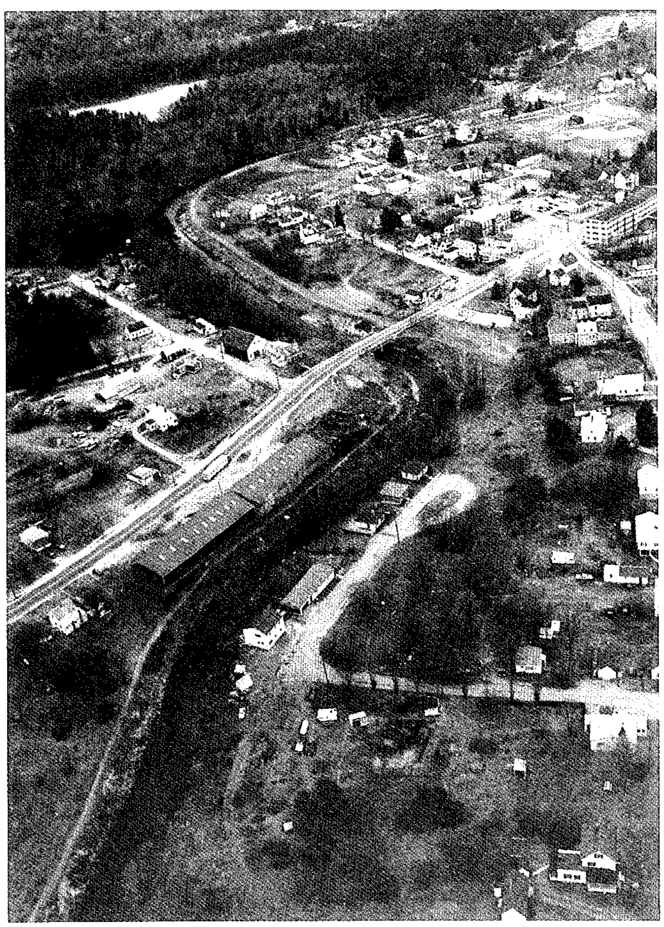
Important to the project are city-built retaining walls, situated on both banks in the section of channel between Water and Marlboro Streets. These walls, constructed in previous years to help control Beaver Brook flooding, act in conjunction with the Corps-built works to provide flood protection to Keene. On the left bank, the retaining walls consist of approximately 120 feet of granite block and about 150 feet of gabion; on the right bank, the retaining wall consists of approximately 85 feet of gabion.

Cocheco River, Farmington

The Cocheco River Local Protection Project in Farmington is located along the Cocheco River.

The entire project protects about 45 acres of industrial, commercial, and residential property in the center of Farmington. Since its completion, it has prevented an estimated $110,000 in flood damages.

The limited channel capacity of the Cocheco River frequently caused the river to overflow, resulting in flood damage to the center of Farmington. The town suffered serious flood damage in March 1936 and May 1954. This limited channel capacity was aggravated by periodic ice jams. Cakes of ice that had lodged against obstructions in the river, such as debris and several small wooded sand bars and islands, plagued Farmington for many years and was the cause of most of the area's flooding.



The Cocheco River Local Protection Project extends along 7800 feet of the Cocheco River and is divided into upper and lower halves by the South Main Street Bridge (center). This photo shows the entire project as it winds through Farmington.

To increase the channel capacity of the Cocheco River, the Corps built a project on the upper part of river between the Central Street Bridge and the South Main Street Bridge. The work, constructed as a small project under Section 205 of the Continuing Authorities Program, was completed between June-November 1956 and cost $87,500. The project was turned over to Farmington for operation and maintenance.

In January 1957, however, ice cakes, flowing from the upper part of the Cocheco River between the Central Street and South Main Street Bridges to the lower part of the river, below the South Main Street Bridge, lodged in the vicinity of Dames Brook, located about 2000 feet below the South Main Street Bridge. The river overflowed and caused considerable flood damage to one of Farmington's major industrial employers. Town officials, businessmen, and manufacturers, weary of the periodic ice jams that continually jeopardized their community, approached the Corps and emphasized the importance of a project that would extend to the lower part of the Cocheco River the same degree of protection afforded to the upper river by the existing project. The Corps responded by constructing a project on the lower river between June-November 1959 at a cost of $48,600. This work was also constructed as a small project under Section 205 of the Continuing Authorities Program, and was turned over to Farmington for operation and maintenance.

The entire project extends along a 7800-foot-long stretch of the Cocheco River. It begins at the Central Street Bridge and ends at a point 4700 feet downstream of the South Main Street Bridge.

Work completed on the upper part of the river centered mostly on the approximately 3100 feet of river between the Central Street and South Main Street Bridges. It involved constructing about 3000 feet of earthfill dike along the left bank of the river. The dike, constructed of materials excavated from the channel, begins at point about 200 feet downstream of the Central Street Bridge and ends at the South Main Street Bridge; Constructing approximately 125 feet of concrete floodwall, 10-12 feet high, along the left bank of the river. The wall extends from the existing masonry wall at the Central Street Bridge to the beginning of the earthfill dike; Constructing a concrete cap on the existing masonry wall to give the wall additional height, thereby providing an extra measure of flood protection; Enlarging and straightening about 3100 feet of the Cocheco River; Straightening about 600 feet of the Mad River at its confluence with the Cocheco River; Removing an abandoned wooden dam; and clearing and snagging about 2000 feet of the Cocheco River. This work extended from the South Main Street Bridge to the mouth of Dames Brook.

Work completed on the lower part of the river, below the South Main Street Bridge, involved widening and deepening about 4000 feet of the Cocheco River, beginning at the South Main Street Bridge and extending downstream; Snagging and clearing an additional 700 feet of the

Cocheco River, beginning at the point where the aforementioned widening and deepening ended; Constructing 200 feet of earthfill dike with stone slope protection along the left bank, just downstream of the bridge. This dike was constructed of materials excavated from the channel; Straightening and widening the lower end of Dames Brook, from the Elm Street Bridge to its confluence with the Cocheco River.

In the early 1960's, the project suffered significant flood damage. Consequently, the Corps repaired and restored the project between September-December 1964. This work included widening and reshaping the channel; constructing stone slope protection at areas subject to severe erosion; and constructing a deflecting stone groin at the confluence of the Mad and Cocheco Rivers. The work was completed as a small project under Section 205 of the Continuing Authorities Program and cost $47,000.

In April 1984, heavy flooding significantly eroded two sections of the 3000-foot-long dike on the upper part of the river. Emergency repairs included placing stone slope protection along these eroded areas and repairing a drain pipe. This work, constructed under the Corps' emergency repairs authority (Public Law 99 of the Flood Control Act of 1941), was accomplished between September-October 1985 and cost $137,000.

A 160-foot-long weir across the Israel River in Lancaster is designed to impound ice, reducing the threat of ice jams downstream. The project protects about 12 acres of commercial, industrial, and residential property.

Israel River, Lancaster

The Israel River Local Protection Project in Lancaster is located on the Israel River, about 93 miles north of Concord. The project is approximately 0.5-mile upstream of the Main Street Bridge, and approximately 1000 feet upstream of the covered bridge on Mechanic Street. The project was built at the site of a former wooden dam owned by the Twin State Gas and Electric Company. The Israel River flows into the Connecticut River about 1.5 miles downstream.

The project protects about 12 acres of commercial, industrial, and residential property in the center of Lancaster, including the Town Hall and police station, from flooding due to ice jams. Data on damages prevented are not available.

The Israel River is a steep, mountainous stream that becomes relatively flat as it flows through Lancaster. During the winter, large amounts of ice form upstream and float downstream to these flatter reaches, where it adheres to the bottom of the channel, particularly in the area of the Main Street Bridge in the center of town. These ice jams reduce the channel depths and limit the flow capacity of the river, causing the river to overflow its banks and flood public and private property. Since 1895, Lancaster has suffered more than 20 ice jam floods, the most serious occurring in March 1968. In March 1970, the Corps constructed an emergency rock dike across the Israel River at a point immediately upstream from the mouth of Otter Brook. The purpose of the dike was to hold floating ice upstream until a permanent structure could be constructed.

Construction of the present project began in May 1980 and was completed in September 1981 at a cost of $552,000. It is a small project, built under Section 205 of the Corps Continuing Authorities Program.

The project consists of a 160-foot-long, six-foot-high weir, made of earth and rock. The weir impounds ice and prevents it from flowing downstream and lodging against the Main Street Bridge. It is protected by layers of gabion, which are steel wire mesh baskets filled with stone, and is covered with 3-5 inches of concrete, which protects the gabion wires from cutting and other damage caused by ice and debris. A sheet of steel constructed along the center of the weir helps prevent water from flowing through the structure. Four openings in the weir, each four feet wide, provide passage for migratory fish. These openings contain slots for wooden stoplogs, which are inserted in late fall to prevent water from passing through the weir and insure a winter pool of about 56 acres behind the weir. The stoplogs are removed in the spring; there is a three-foot-deep stilling basin, lined with gabion, located immediately downstream of the weir. Water coming through the weir at a high velocity hits the stilling basin, which dispels the water's energy and considerably slows its acceleration; also, a 90-foot-long earthfill dike with stone slope protection was constructed in a low area adjacent to the weir's right abutment. The dike, with a maximum height of 10 feet, confines the river when the river is restricted by ice jamming at the weir.

Because of the project's unique design, it is monitored by the Corps of Engineers to measure its effectiveness.

Keene

The Keene Local Protection Project is located along the Ashuelot River in Keene and Swanzey.

The project increases the Ashuelot River's channel capacity, allowing the reservoir behind the dam at Surry Mountain Lake, located five miles upstream, to empty more rapidly. This increased channel capacity improves the river's flow conditions, which in turn reduces local flooding in Keene, improves the efficiency of drains and sewers in Keene during high water periods, and helps reduce flooding on farm fields situated along the river. Data on damages prevented are not available.

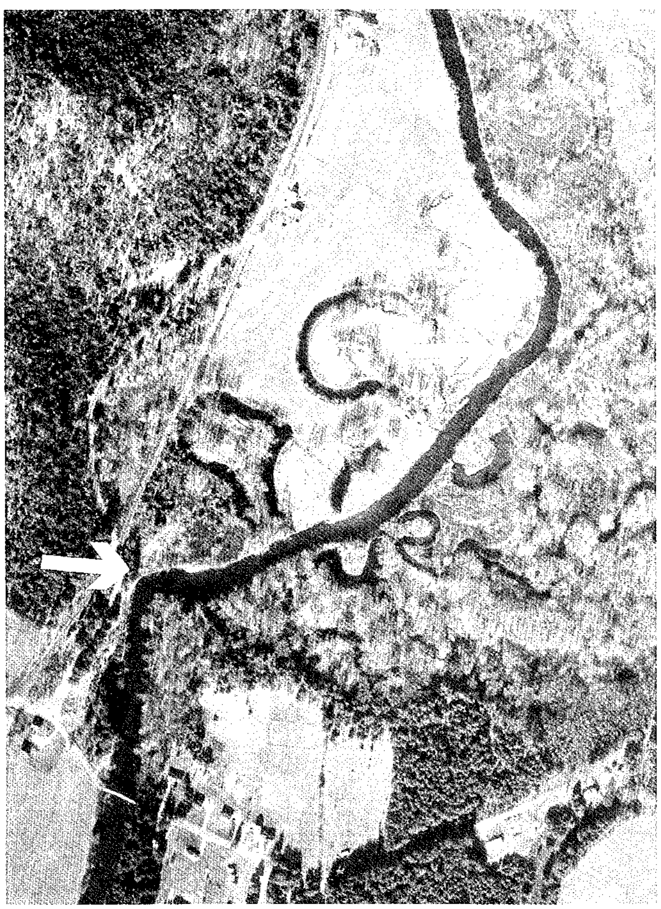
Construction was accomplished between June-August 1954 at a cost of $44,100. The project is maintained by Keene.

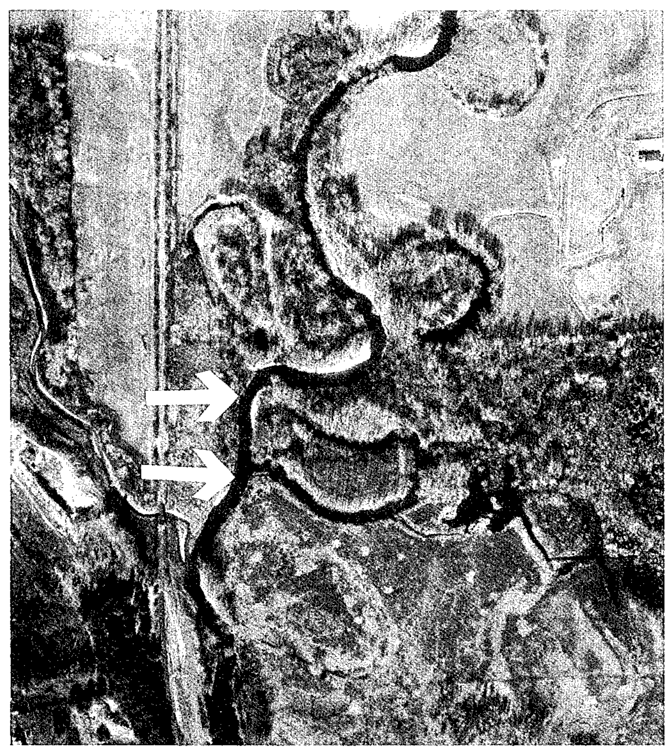
The project involved snagging and clearing approximately 22,800 feet of the Ashuelot River, beginning at the railroad bridge in Keene and extending to the covered bridge at Swanzey Station in Swanzey. The work included removing trees, brush, and other debris in the river.

The work also involved the excavation of two cutoff, or "short cut" channels. The Ashuelot River flows in a north-south direction. However, two sections of the river in Keene and Swanzey meandered back and forth in an east west direction for several thousand feet. The cutoff channels bypass these winding, roving sections of channel and provide a "short cut" route for the river, allowing a more direct north-south flow. Where once the river meandered east-west for a total of 5600 feet, the two cutoff channels now permit the river to flow in a north-south direction for approximately 1800 feet. One cutoff channel is located in the vicinity of the mouth of the South Branch in Swanzey, and the second is 500 feet above the mouth of White Brook in Keene.

Lincoln

The Lincoln Local Protection Project is located on the East Branch of the Pemigewasset River in Lincoln, about 80 miles north of Concord. The East Branch joins with the Pemigewasset River about one mile downstream of the project.





The Keene Local Protection Project involved the excavation of two "short cut" channels in the Ashuelot river that eliminated winding sections of stream. The sections of the Ashuelot River between the white arrows in the above photographs delineate the "short cut" channels. One cutoff channel is located in the vicinity of the mouth of the South Branch in Swanzey (left), and the other is 500 feet above the mouth of White Brook in Keene.

The Lincoln Local Protection Project, located on the East Branch of the Pemigewasset River, involved restoring 1400 feet of existing dike on the right bank of the river (above) and excavating 1350 feet of channel.

The project provides flood protection along the right bank of the river in the vicinity of the Mill Shopping Mall, the site of a paper mill at the time the project was constructed. Data on damages prevented are not available.

In October 1959, Lincoln and other communities in northern New England experienced severe flooding. A locally-built wooden crib dike on the East Branch of the Pemigewasset River, which provided flood protection to the former paper mill, was seriously damaged by the flood. Although the paper mill did not suffer any flood damage, it was feared that additional flooding, however minor, might cause the dike to fail and leave the paper mill vulnerable to flood damage. Lincoln officials, fearful of losing what was at that time the town's major employer, asked the Corps to repair and restore the dike. The restoration and repair work took place between July-December 1960 and cost $140,000. The project is operated and maintained by Lincoln.

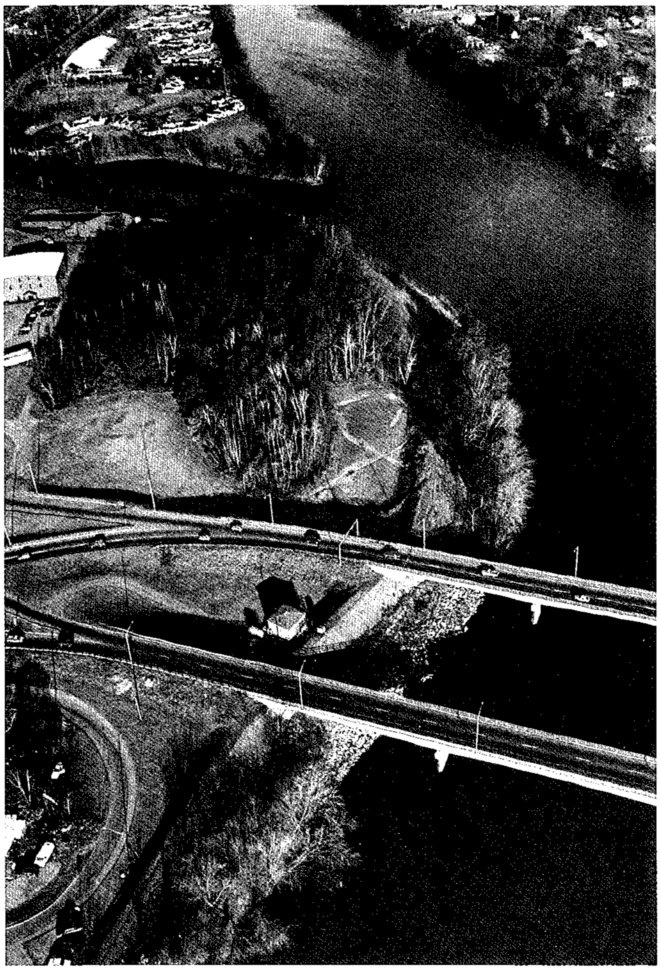
The project begins at a dam that was owned by the former paper mill and extends 1450 feet downstream along the west bank of the East Branch of the Pemigewasset River. Work included restoring 1400 feet of existing dike. This dike begins at the dam's west abutment and extends 1450 feet downstream along the river's right bank. The restoration work included the placement of stone slope protection; constructing 230 feet of earthfill dike with stone slope protection. The dike begins at the dam's west abutment and extends northerly; and excavating 1350 feet of channel. The October 1959 flood washed much of the stone protection covering the dike into the East Branch of the Pemigewasset River. The Corps removed these stones and boulders from the river, and those stones with a circumference larger than six inches became part of the stone slope protection constructed by the Corps on the restored dike.

Nashua

The Nashua Local Protection Project is located at the confluence of the Nashua and Merrimack Rivers in Nashua, about 18 miles south of Manchester. The project protects about 70 acres of industrial and residential property in the lower section of the city. It has prevented an estimated $172,000 in flood damages.

Nashua experienced serious flooding in both March 1936 and September 1938. In 1936, the lower section of the city was flooded to depths ranging from ten to 17 feet, causing damage estimated at $1.9 million. In 1938, this area was flooded to depths ranging from five to eight feet. Construction of the project began in June 1946 and was completed in May 1949 at a cost of $273,000. The project is operated and maintained by Nashua.

The project consists of an earthfill dike approximately 3025 feet long with a maximum height of 16 feet. The dike starts at the Boston and Maine Railroad Bridge that spans the Nashua River and extends easterly along the river's right bank to the Merrimack River. The dike then continues southerly along the Merrimack River before ending at high ground south of Crown Street. The dike is continuous except for three sections of concrete floodwall. Stone slope protection was placed on the dike in areas where the river velocities are high; three sections of concrete floodwall totalling approximately 400 feet. One section of wall is on the right bank of the Nashua River, near its confluence with the Merrimack River. The other two sections are on either side of the Hudson Bridge, along the right bank of the Merrimack River; a pumping station, located adjacent to the Hudson Bridge, behind the dike. The pumping station handles interior storm and sanitary drainage from an area of 615 acres within the city. This drainage is carried through a conduit and is discharged into the Merrimack River; a second earthfill dike approximately 400 feet long with a maximum height of five feet. This dike, located approximately 600 feet south of the 3025-foot-long dike's southern end, is situated several hundred feet inland from the Merrimack River. It lies perpendicular to the river, across Cinder Road.



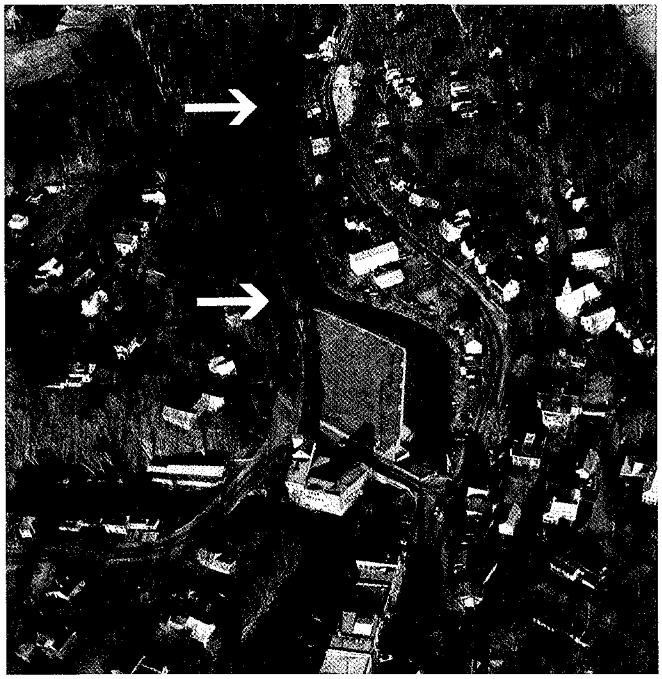
One of the features of the Nashua Local Protection Project is a 3025-foot-long dike that helps protect 70 acres of industrial and residential property. The dike starts along the right bank of the Nashua River (top left). After the Nashua River joins the Merrimack River, the dike continues along the Merrimack River before ending several hundred feet past Route 111 (center). While much of the dike is hidden under brush, a section of dike with stone slope protection can be seen between the north and south overpasses of Route 111. The structure behind this section of dike is the pumping station.

Stony Brook, Wilton

The Stony Brook Local Protection Project in Wilton is located on Stony Brook, near its confluence with the Souhegan River. It is about 18 miles northwest of Nashua. The project reduces ice jam flooding on Stony Brook, safeguarding residential, commercial, and industrial properties in Wilton's downtown area. Data on damages prevented are not available.

Stony Brook was prone to flooding from heavy rainfall, which caused serious flood damage in September 1938, June 1944, and October 1955. However, most flooding on Stony Brook was caused by ice jams. In late winter and early spring, ice floating downstream on Stony Brook would lodge against obstructions in the stream, limiting its flow capacity. These obstructions included several boulders, shoals, and logs that supported a thick growth of brush; soil that had sloughed off the east bank; and masonry blocks that had fallen from adjacent walls. The ice jams caused Stony Brook to overflow its east bank, flooding residential and commercial properties. Ice jams caused serious flooding in March 1936, March 1968, January 1969, and January 1970. Following the flood of January 1970, which caused record damages, town officials contacted the Corps and requested assistance to protect property that was vulnerable to ice jam flooding. The Corps started and completed the project in November 1971 at a cost $19,500. It is a small project, built under Section 208 of the Continuing Authorities Program, and is maintained by Wilton.

The project involved snagging and clearing trees, brush, boulders, logs, and other debris from a 1000-foot-reach of Stony Brook. The project begins near the northerly of two dams on Stony Brook and extends 1000 feet downstream, ending about 600 feet above the intersection of Highland and Main Streets. The removal of this debris restored the channel to its original width of 65 feet. The gravel and soil removed from Stony Brook was placed on the east bank.



The Corps snagged and cleared a 1000-foot-long stretch (between the arrows) of Stony Brook to reduce flood damages caused by ice jams.

Navigation

The Corps has completed 10 navigation projects in New Hampshire that have improved rivers, harbors, and lakes used by commercial interests, fishermen, and the many recreational boaters that benefit from New Hampshire's coastal and inland waterways.

Initial work on some of the projects dates back to the 19th century. However, most of the navigational work in today's rivers and harbors has been constructed by the Corps within the past 50 years, costing an aggregate $6.65 million. (More information on the navigational role of the Corps is available).

The following pages describe the Corps' navigation projects in New Hampshire. Depths given for channels and anchorages are those at mean low water.

The project at Lake Winnipesaukee in Laconia consists of a navigable passageway through Weirs Channel (center). Weirs Channel connects Meredith Bay (bottom) with Paugus Bay (top).

Navigation Projects in New Hampshire

Bellamy River

Cocheco River

Exeter River

Hampton Harbor

Isles of Shoals Harbor

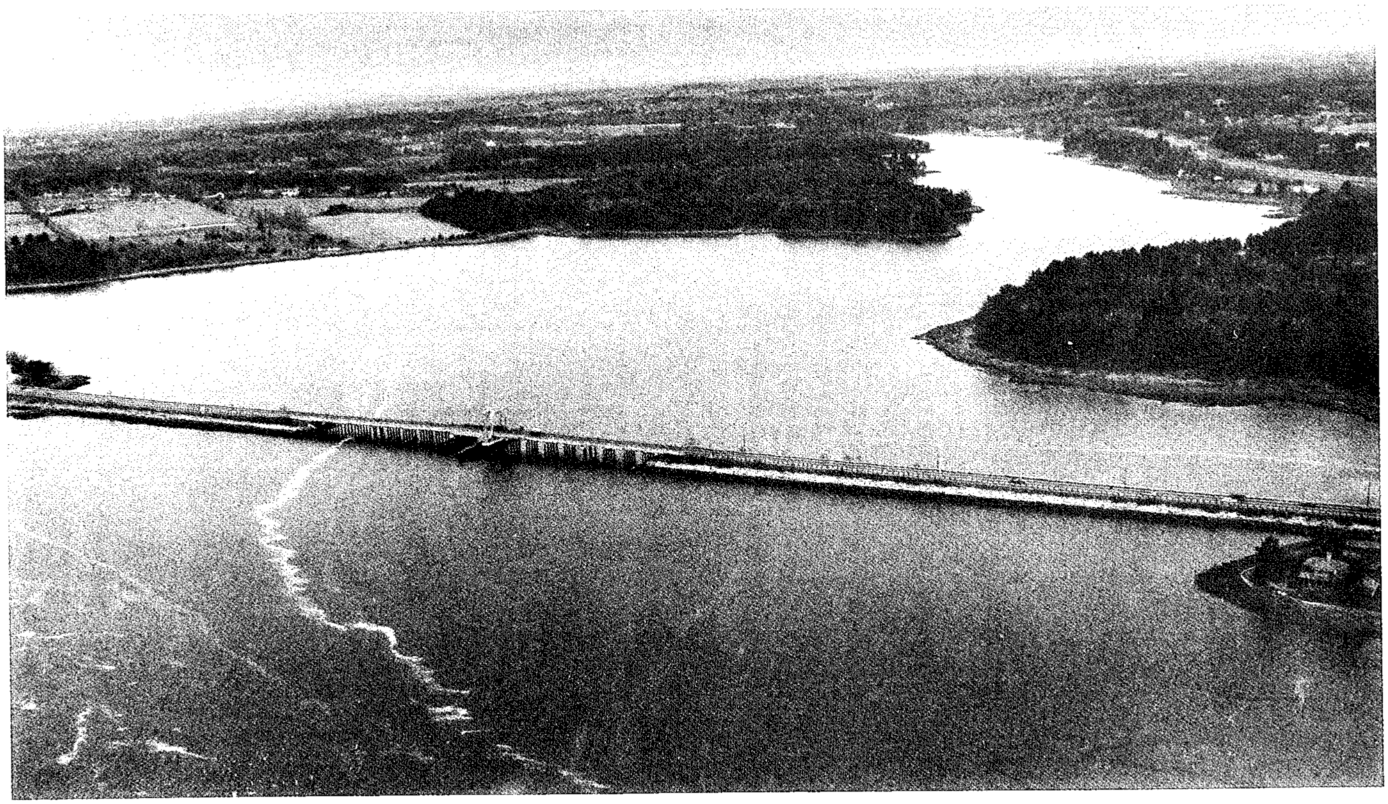
Lake Winnipesaukee

Lamprey River

Little Harbor

Portsmouth Harbor and Piscataqua River

Rye Harbor



The entrance to the Bellamy River, which flows through Newington and Dover.

Bellamy River

The Bellamy River flows through Dover into Little Bay, which connects Great Bay to the southwest with the Piscataqua River to the east, in Newington. The river today is used only by recreational boaters.

In the latter part of the 19th and early 20th century, the Bellamy River was used as a shipping channel between Great Bay and Sawyer's Mill in Dover, with brick being the principal commodity. Completed in 1896 to accommodate commercial navigation, the project consists of a four-mile-long channel, five feet deep and 50 feet wide, extending from Little Bay to Sawyer's Mill, near the Route 108 Bridge. The project lies on the west side of Dover Point.

No shipping has been reported on the river for many years.

Cocheco River

The Cocheco River flows for 34 miles in a southeasterly direction and joins with the Salmon Falls River in Dover to form the Piscataqua River. The Cocheco River is located about nine miles northwest of Portsmouth and serves small recreational and fishing vessels.

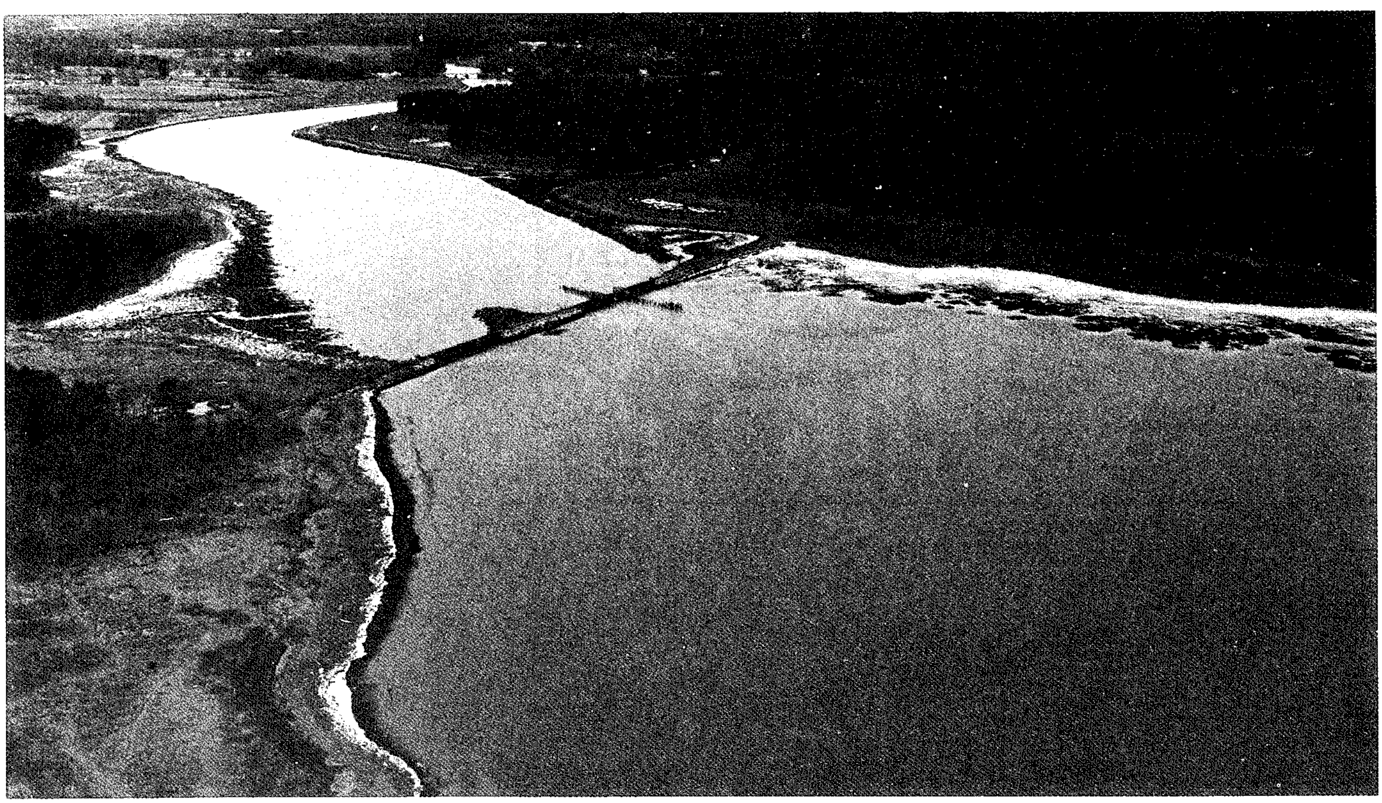
This project, completed in 1906, consists of a three-mile channel, seven feet deep and 60-75 feet wide (7.5 feet deep and 50 feet wide in areas where rock was encountered), extending up the Cocheco River from its confluence with the Salmon Falls River to Dover's Upper Narrows area, located near the town center. The project was built to facilitate shipping, which at that time consisted chiefly of coal and building materials. However, no commercial navigation has been reported on the river for many years.

Exeter River

The Exeter River originates in Chester and follows a meandering course eastward for 43 miles before emptying into Great Bay in Newmarket, near the mouth of the Lamprey River and about eight miles southwest of Portsmouth. The Corps' project is on the lower 8.3 miles of the Exeter River, known locally as the Squamscott River, which flows through Exeter, Newfields, Stratham, and Newmarket. Used mostly by small recreational craft, boating activity today is limited primarily to the river's lower two miles.

The Corps began work on the Exeter River in 1882 to facilitate the shipment of coal from Great Bay to Exeter. This work consisted of constructing an 8.3-mile-long channel, 40 feet wide, extending from Great Bay to the upper wharves at Exeter, in the vicinity of what is now the Phillips Exeter Academy Boathouse. For the channel's first 5.6 miles, from Great Bay to Oxbow Cut, the channel is six feet deep. From Oxbow Cut to the upper wharves at

The Cocheco River (left) joins with the Salmon Falls River (right) in Dover to form the Piscataqua River.



The mouth of the Exeter River at Great Bay in Newmarket.

Exeter, the channel was constructed to a depth of five feet. In 1903, this latter section of channel, from Oxbow Cut to the upper wharves at Exeter, was deepened to 5.5 feet, and a five-foot-deep turning basin, 200 feet long and 110 feet wide, was constructed at the upper wharves in Exeter.

In 1911, the Corps modified the project by straightening the channel at the Stratham Bridge (Route 108).

Hampton Harbor

Hampton Harbor in Hampton is situated behind Seabrook Beach and Hampton Beach, about 1.5 miles north of the New Hampshire-Massachusetts state line. The entrance to Hampton Harbor separates Seabrook and Hampton Beaches and forms the mouth of the Hampton River. A small lobstering fleet, charter fishing boats, and numerous recreational craft are based in the harbor.

The project, completed in 1965, involved:

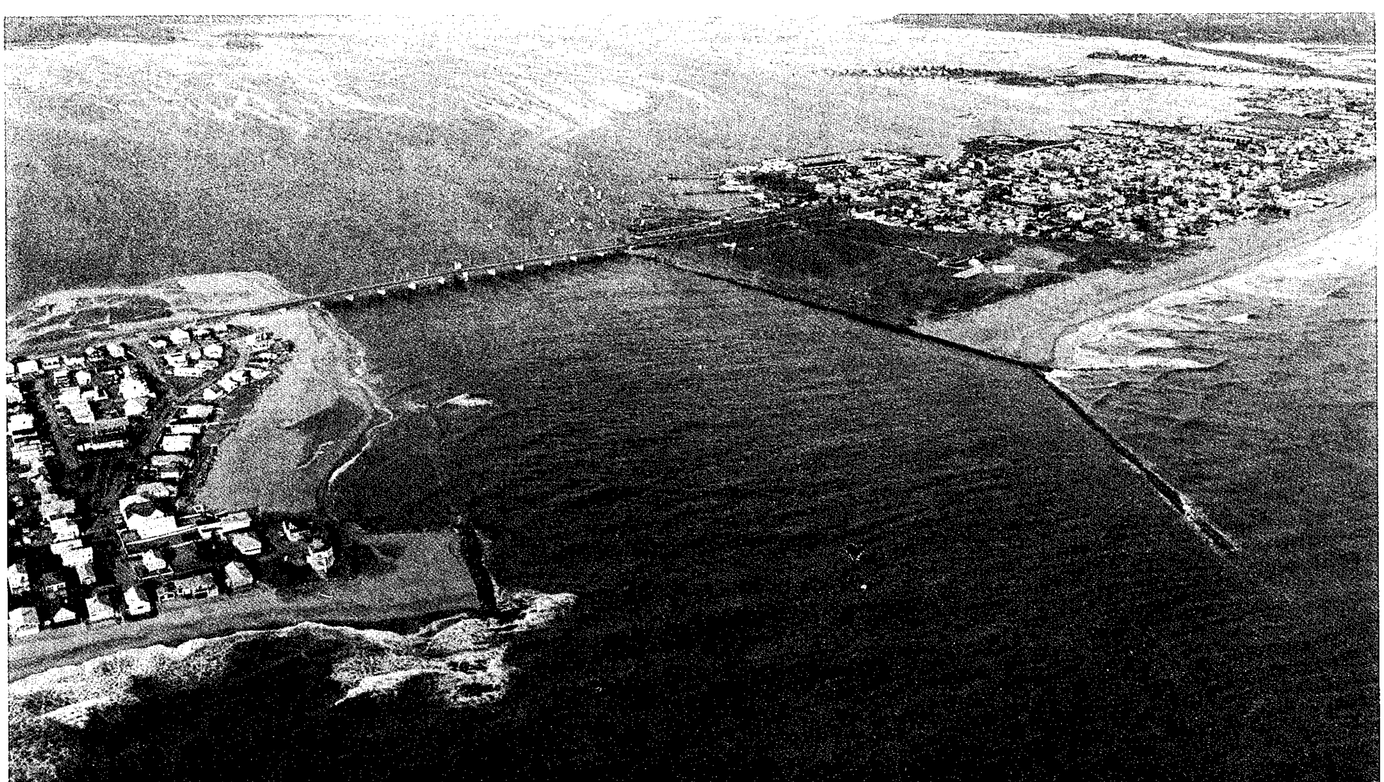
- Constructing a 0.7-mile-long channel, eight feet deep and 150 feet wide, extending from the ocean through the entrance to the harbor. Material dredged from the channel was placed at the northern end of Hampton Beach in conjunction with the Corps' beach replenishment project.
- Extending and raising existing state-built stone jetties on each side of the entrance to the harbor. The existing 1300-foot-long north jetty was extended another 1100 feet, and the outer 300 feet of the existing 1000-foot-long south jetty was raised. A walking surface was constructed on the top of the north jetty extension for fishing.

Work at Hampton Harbor was constructed as a small project under Section 107 of the Continuing Authorities Program.

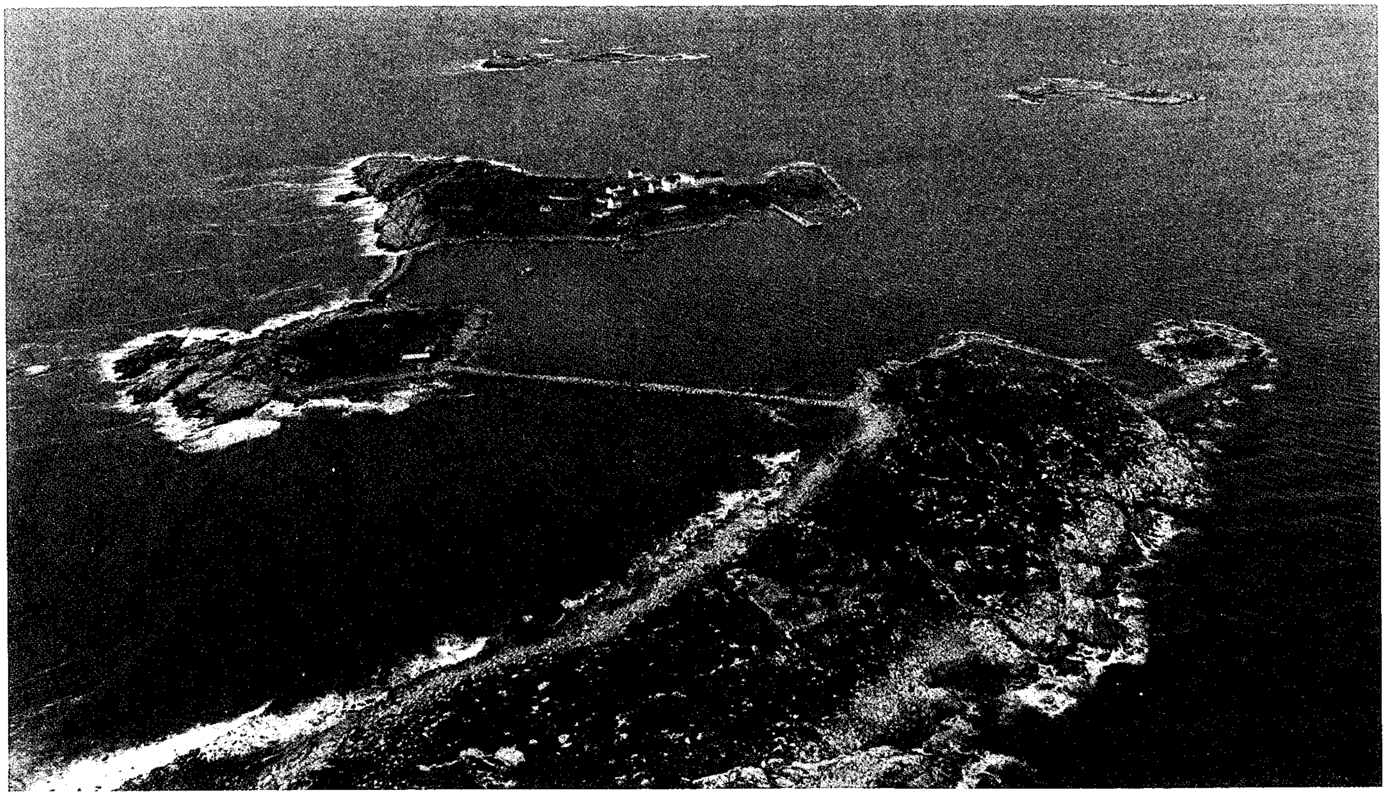
Isles of Shoals Harbor

Discovered by Captain John Smith in 1614, the Isles of Shoals are a three-mile-long cluster of eight rocky islands and ledges located off the coast of New Hampshire and Maine. Bisected by the boundary line of Rye, New Hampshire, and Kittery, Maine, the Isles of Shoals are about five miles east of Rye Harbor. Four of the islands Star, Cedar, Smuttynose, and Malaga are situated such that they afford a small harbor, known as Gosport Harbor. This harbor, 32 acres in area, is used by commercial and charter fishing boats and recreational vessels, as well as excursion boats from Portsmouth. It is also used by the U.S. Coast Guard out of Portsmouth during search and rescue operations. The Isles of Shoals are popular for summer conferences and are home to a marine biology center operated by Cornell University.

Work in the Isles of Shoals began as early as 1821, when private interests constructed a stone breakwater between



The entrance to Hampton Harbor separates Seabrook (left) and Hampton Beaches. The Corps constructed a channel through the entrance and extended and raised the stone jetties on either side.



The three breakwaters at the Isles of Shoals form Gosport Harbor, in the center of the photo. The first breakwater connects Malaga Island, the small island at the far right, with the much larger Smuttynose Island; a second breakwater extends from Smuttynose Island across to Cedar Island (middle of photo); and the third breakwater connects Cedar Island with Star Island.

Malaga and Smuttynose Islands. In 1904, the Corps repaired and strengthened the breakwater to a length of 240 feet and constructed a second stone breakwater, 700 feet long, between Smuttynose and Cedar Islands. In 1913, the Corps repaired and strengthened the existing breakwaters and constructed a third stone breakwater, 530 feet long, between Cedar and Star Islands. The breakwaters provide vessels with a safe refuge in Gosport Harbor.

Lake Winnipesaukee

Lake Winnipesaukee in central New Hampshire is a renowned summer resort and boating center situated about 30 miles northeast of Concord. The 72-square-mile lake, the largest in the state, has a maximum length of approximately 20 miles and a maximum width of about eight miles. The western end of the lake, known as Meredith Bay, discharges into the 3000-foot-long Weirs Channel, which leads into Paugus Bay, known locally as Long Bay (Paugus Bay forms the head of the Winnipesaukee River). Located in Laconia, Weirs Channel is used principally by mail boats, passenger boats, and numerous recreational craft.

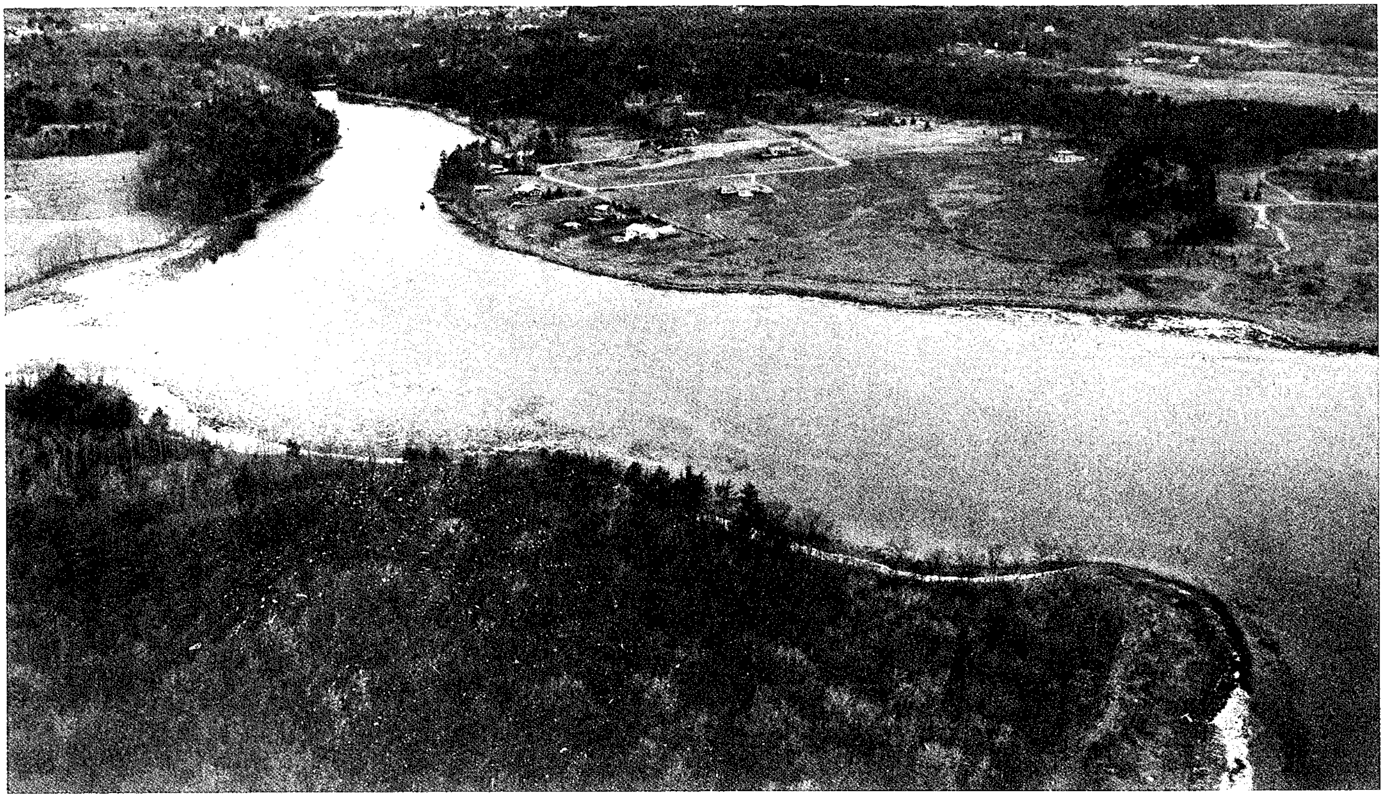
The project, completed in 1882, involved constructing a navigable passageway through Weirs Channel so that boats could travel safely from Paugus Bay to Meredith Bay. Weirs Channel was dredged to a depth of five feet and a width of 50 feet, and obstructing shoals were removed.

Lamprey River

The Lamprey River flows easterly for 42 miles and empties into Great Bay in Newmarket, about eight miles west of Portsmouth. A small recreational fleet is based near the mouth of the river.

During the 1880s, Newmarket required 5000 tons of coal annually to heat large manufacturing plants, several commercial establishments, and residential areas. Other commodities shipped to the town, including salt, iron, and cement, amounted to between 7-8000 tons annually. Completed in 1883 to accommodate commercial shipping, the project consists of a 2.5-mile-long channel, five feet deep, extending from Great Bay to the vicinity of the Route 108 Bridge in Newmarket. The first two miles of the channel, from Great Bay to the Lower Narrows, is 100 feet wide, and the channel's last 0.5 mile, from the Lower Narrows to the vicinity of the Route 108 Bridge in Newmarket, is 40 feet wide.

No shipping has been reported on the Lamprey River for many years.



The entrance to the Lamprey River in Newmarket.

Little Harbor

Little Harbor is situated between the island of New Castle to the north and Rye to the south. The harbor's northwesterly end, located at the Bascule Bridge (Route 1B), leads into the southerly end of Portsmouth Harbor. Little Harbor is used today mostly as an access route for recreational and fishing boats and other small craft based at Sagamore Creek, a popular boating center situated immediately northwest of the harbor. Small boats also use Little Harbor as a refuge.

Commercial sailing schooners operating along the coast at the turn of the century needed a safe harbor of refuge as they waited for moderate tides in Portsmouth Harbor. At that time, Little Harbor was too shallow to accommodate these schooners. The Corps began work in Little Harbor in 1887 and, after several modifications, completed the project in 1903. The project consists of:

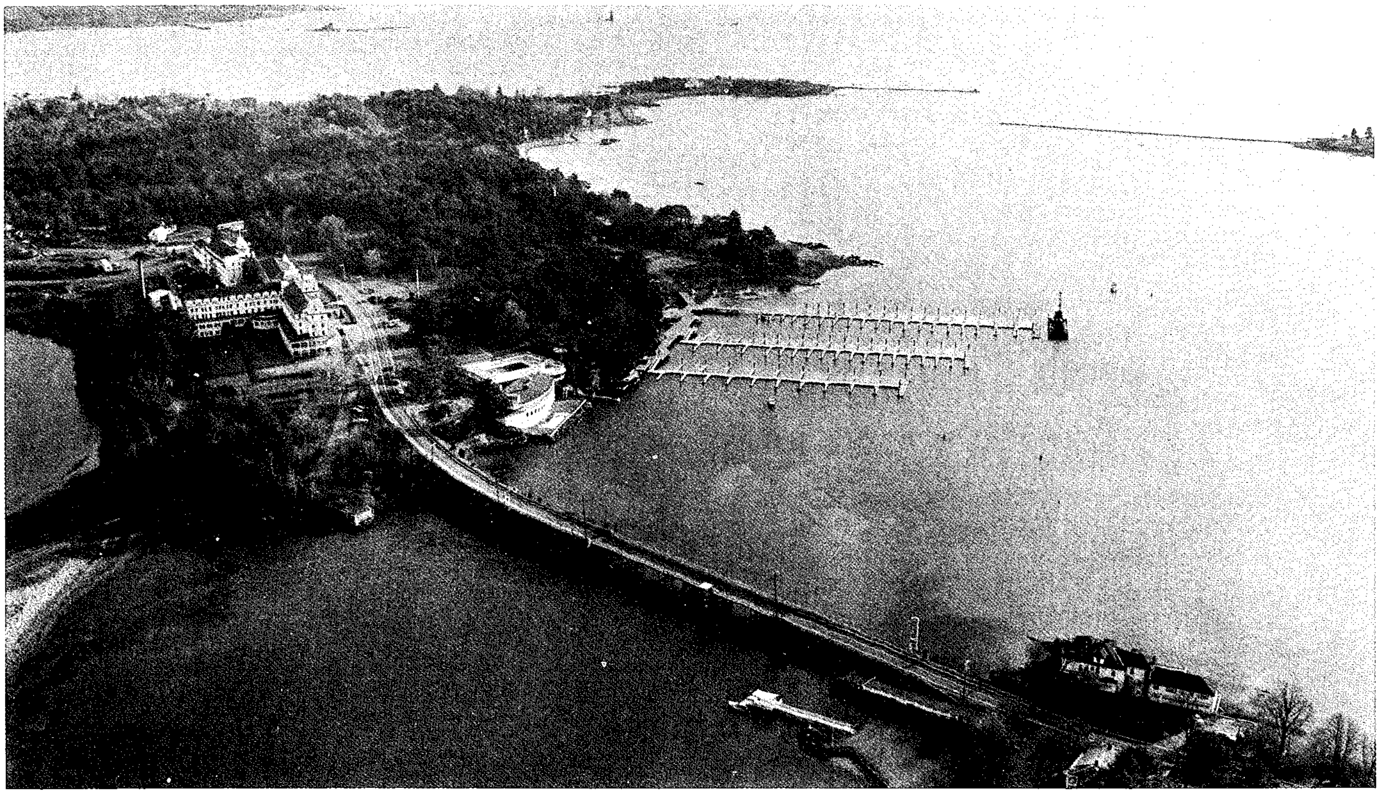
- Two stone breakwaters, one on each side of the harbor entrance. The north breakwater, off Jaffrey Point in New Castle, is 550 feet long. The south breakwater, off Frost Point in Rye, is 900 feet long. The breakwaters were completed in 1894.
- A 3000-foot-long entrance channel, 12 feet deep and 100 feet wide, extending through the harbor to the vicinity of the Bascule Bridge (Route 1B).
- A 12-foot-deep anchorage basin, 700 feet long and 300 feet wide (about 40 acres in area), lying immediately south of the entrance channel.

The commercial sailing schooners for which the project was designed were phased out of existence in the late 1920s.

Portsmouth Harbor and Piscataqua River

Formed by the confluence of the Salmon Falls and Cocheco Rivers, the Piscataqua River originates at the boundary of Dover, New Hampshire and Eliot, Maine, and flows southeasterly for 13 miles to Portsmouth Harbor, comprising a partial border between the two states. The last 8.8 miles of the Piscataqua River constitute Portsmouth Harbor, which stretches across New Castle, Portsmouth, and Newington, and the Maine communities of Kittery and Eliot.

Located about 50 miles northeast of Boston, Portsmouth Harbor is the sole deep draft harbor in New Hampshire. It handles about 3.5 million tons of shipping a year for New Hampshire, eastern Vermont, and southern Maine. Items include petroleum products, iron and steel scrap, salt, limestone, and fish products. The harbor is used by submarines



The project at Little Harbor, situated between New Castle and Rye, included the construction of a breakwater off Frost Point (right); a breakwater off Jaffrey Point (left of the Frost Point breakwater); and an entrance channel leading up to the Bascule Bridge (bottom).

Portsmouth Harbor. The 6.2-mile-long channel, 35 feet deep and generally 400 feet wide, was widened by removing ledge in its bends, including one at Badgers Island, just left of center in the photo.

from the Portsmouth Naval Shipyard in Kittery and for fuel deliveries to Pease Air Force Base in Newington. Portsmouth Harbor is also used extensively by a large lobstering fleet, charter fishing vessels, commercial fishermen, excursion boats to the Isles of Shoals situated nine miles offshore, and local and transient boats based at or visiting the nearly 20 boating facilities in the area.

Initial work in Portsmouth Harbor began in 1881. It consisted of:

- Constructing a 1000-foot-long breakwater between New Castle and Goat Islands. The breakwater, completed in 1881, now serves as a causeway for an access road to New Castle.
- Removing two ledge areas in the middle of the harbor. One area, Gangway Rock, was opposite the western end of the Portsmouth Naval Shipyard, on the New Hampshire side of the channel. Removal of this ledge to a depth of 20 feet began in 1881 and was completed in 1888. The second area was about 0.6 mile upstream, near the southwestern end of Badgers Island, on the Maine side of the channel. Removal of this ledge to a depth of 18 feet began in 1881 and was completed in 1891.

The Corps has more recently completed two projects in Portsmouth Harbor constructed at separate times. The first project, approved by Congress and completed in 1966, consists of:

- A 6.2-mile-long channel, 35 feet deep and generally 400-600 feet wide, extending northwesterly from deep water between New Castle and Seavey Islands (approximately 2.6 miles from the mouth of the Piscataqua River) to a turning basin located about 1700 feet past the Atlantic Terminal Sales dock in Newington. The bends were widened to approximately 700 feet by removing ledge at Henderson Point, Gangway Rock, Badgers Island, the U.S. Route 95 Bridge, and Boiling Rock (The small shoal at the U.S. Route 95 Bridge was removed in 1969).
- Two 35-foot-deep turning basins. The first turning basin is located above Boiling Rock and is 950 feet long. The second is situated at the end of the aforementioned 6.2-mile-long channel in Newington and is 850 feet long.

The Corps completed a second project in 1971 that serves a large recreational and small lobstering fleet based in the area of Sagamore Creek, a popular boating center located at the southerly end of Portsmouth Harbor. This work, constructed as a small project under Section 107 of the Continuing Authorities Program, consists of:

- A 0.4-mile-long main channel extending from Little Harbor, located immediately south of Portsmouth Harbor between New Castle and Rye, through the Bascule Bridge (Route 1B), then west to the mouth of Sagamore Creek. The channel is six feet deep and 100 feet wide. At Sagamore Creek, the channel forks into northern and westerly channels, described below.
- A 75-foot-wide northerly channel, six feet deep, extending 0.7 mile between Leachs Island and Portsmouth to deep water south of the bridge connecting Shapleigh and Goat Islands.
- A 75-foot-wide westerly channel, six feet deep, extending 0.9 mile up Sagamore Creek to the public landing at the Sagamore Avenue Bridge in Rye. A six-foot-deep anchorage, three acres in area, was constructed at the upper end of the channel.

The swift currents of the Piscataqua River make Portsmouth Harbor one of the fastest flowing commercial port waterways in the northeastern United States. Along with a twisting channel that features sharp bends, inadequate turning basins, constricted areas, narrow lift bridges, and submerged ledges, these fast currents make navigation in Portsmouth Harbor increasingly difficult, especially for vessels approaching 700 feet in length. With petroleum representing over 60 percent of the port's commerce, an accident involving a petroleum carrier could result in an oil spill with catastrophic environmental and economic consequences. In recent years, the amount of waterborne commerce handled by Portsmouth Harbor has increased, and the harbor is expected to play a continuing and significant role in the region's economy. However, unless the harbor is improved to accommodate more and larger vessels and made safer for deep-draft navigation, it will not remain competitive.

At the request of Congress, the Corps studied the harbor's dangerous navigable conditions and designed a plan that addresses the problem. This plan includes widening the section of channel between the two vertical lift bridges from 600 to 1000 feet; widening the northern limit of the channel adjacent to Badgers Island by 100 feet; and widening the southern limit of the channel at Goat Island from 400 to 550 feet.

The portion of the improvement project involving widening the channel between the two vertical lift bridges from 600 to 1,000 feet along with the widening of the northern limit of the channel adjacent to Badgers Island by 100 feet was completed in July 1990. The balance of the project that provides for widening the southern limit from 400 to 550 feet will be constructed as soon as the required State funds become available.

Rye Harbor

Rye Harbor

Rye Harbor in Rye is located about five miles south of Portsmouth Harbor. Roughly rectangular in shape, Rye Harbor is about 2000 feet long, 900 feet wide, and 39 acres in area. It is used by lobstering and fishing fleets, charter boats, and recreational craft.

In 1941, the state built an eight-foot-deep anchorage, about 10 acres in area, at the head of the harbor. The Corps project was completed in 1962 and consists of:

- A 2300-foot-long channel, 100 feet wide, extending from the ocean to the head of the harbor, immediately north of the state-built anchorage. The channel is 10 feet deep for its first 600 feet, then becomes eight feet deep for 1700 feet, to the head of the harbor.
- A six-foot-deep anchorage, five acres in area, on the north side of the channel.
- An eight-foot-deep anchorage, five acres in area, on the south side of the channel.
- The repair and restoration of two existing state-built breakwaters situated on each side of the harbor entrance. The north breakwater is 540 feet long, and the south breakwater is 530 feet long. The breakwaters were constructed in 1939.
- The removal of two small ledge areas (This work was done in 1964).

Shore and Bank Protection

Of the five New England states with a coastline on the Atlantic Ocean, New Hampshire's 40-mile coast is the shortest. About 28 miles of coastline are privately owned, 10 miles are owned by state and local government, and two miles are owned by the federal government. The state has approximately 4075 miles of rivers and streams, the lowest number in New England next to Rhode Island's 724.

The Corps has constructed six shore and bank protection projects in New Hampshire to stem erosion of the shoreline and riverbanks. Two of these projects were built to protect the shoreline and four were constructed to strengthen inland streambanks. Total construction costs amount to $1.5 million.

The following pages describe the Corps' shore and bank protection projects in New Hampshire.

The shore can take a beating from storm driven winds and waves. In September 1961, Hurricane Esther raised havoc with Rhode Island's Narragansett Pier, slamming waves against the seawall and flooding adjacent streets. (Copyright 1961 The Providence Journal Company*).*

Shore and Bank Protection Projects in New Hampshire

Charlestown

Hampton Beach

North Stratford

Shelburne

Wallis Sands State Beach

West Stewartstown

The 1300 feet of stone slope protection along the Connecticut River in Charlestown protects the town's wastewater treatment facility (center).

Charlestown

The project in Charlestown is located along the Connecticut River, which comprises the New Hampshire-Vermont border. Charlestown is about 25 miles north of Keene.

A section of the Connecticut River's left bank, near Charlestown's wastewater treatment facility, was eroding at the rate of 8-10 feet a year, posing a threat to the plant's stability. This section of the river is part of a pool used by the New England Power Company's hydroelectric power plant in Bellows Falls, Vermont, located about seven miles downstream. The erosion of the river's left bank was caused by the river's high velocity during flood periods, and also its oscillating water levels, which fluctuated relative to the amount of electricity being generated at the plant.

To stem the erosion and protect the wastewater treatment facility, the Corps constructed 1300 feet of stone slope protection along the east bank. The project was built between October 1974 and January 1975 at a cost of $113,000. It is a small project, constructed under Section 14 of the Continuing Authorities Program.

Hampton Beach

Hampton Beach in Hampton is one of the most popular public beaches in New England. It is approximately 12 miles south of Portsmouth and 1.5 miles north of the New Hampshire-Massachusetts state line.

The Corps first completed work at Hampton Beach in 1955 when 6450 feet of beach was restored and widened by the direct placement of sand. The work begins at Haverhill Street and heads north along the shoreline. The first 5200 feet were widened to a general width of 150 feet, and the last 1250 feet of beach were widened to 175 feet. The cost of this work was $374,300.

In 1965, the Corps completed additional work at Hampton Beach. The northern 2200 feet of beach was replenished, and a 190-foot-long stone groin was constructed. The beach nourishment starts in the vicinity of Church Street and continues northward, and consists of sand obtained from the dredging of the channel at Hampton Harbor. This additional work cost $272,200.

The beach was seriously damaged by a storm in February 1972, when much of the New Hampshire coastline was declared a National Disaster Area. The Corps completed a restoration of the beach in September 1973 at a cost of $415,000.

North Stratford

This project, located in the North Stratford section of Stratford, is situated along the left bank of the Connecticut River, adjacent to the Bloomfield (Vermont)-North Stratford Bridge on Route 105 and the town's fire station. The project is about 20 miles south of the Canadian border.

North Stratford suffered serious flooding from ice jams in 1964, 1970, and 1973. In March 1979, an ice jam caused record flooding, washing away 2000 feet of the Canadian National Railroad, destroying 27 homes, and causing damages estimated at $3.5 million. These floodwaters significantly undercut a section of the Connecticut River's left bank where the fire station is located, posing an immediate threat to the facility. This section of the left bank, situated at a bend in the river, is subject to ice flow abrasion and had eroded considerably since the fire station was constructed two years previously. The fire station also housed the town library and selectman's office.

To stem further erosion and safeguard the fire station, the Corps built 300 feet of stone slope protection along the riverbank. Constructed between October-December 1981, the work cost $180,000. It is a small project, built under Section 14 of the Continuing Authorities Program.

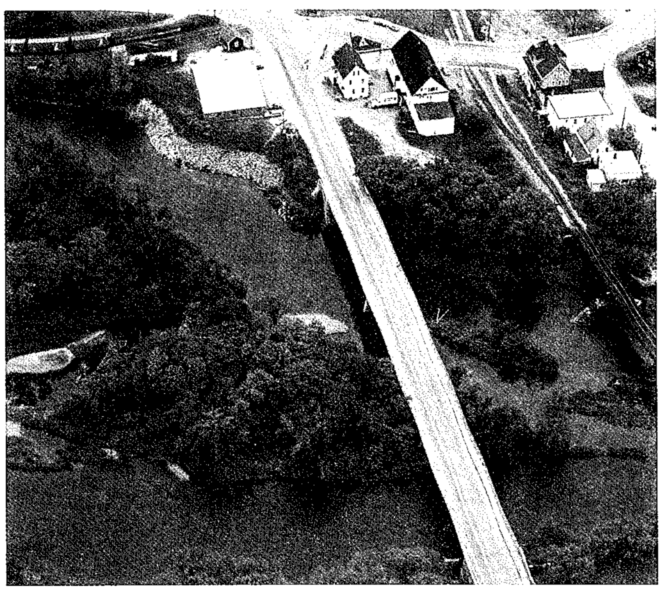
Shelburne

The project in Shelburne is located along the Androscoggin River at the Easterly Bridge, which provides access to the town's Hark Hill section. Shelburne lies on the New Hampshire-Maine border, about 95 miles north of Portsmouth.

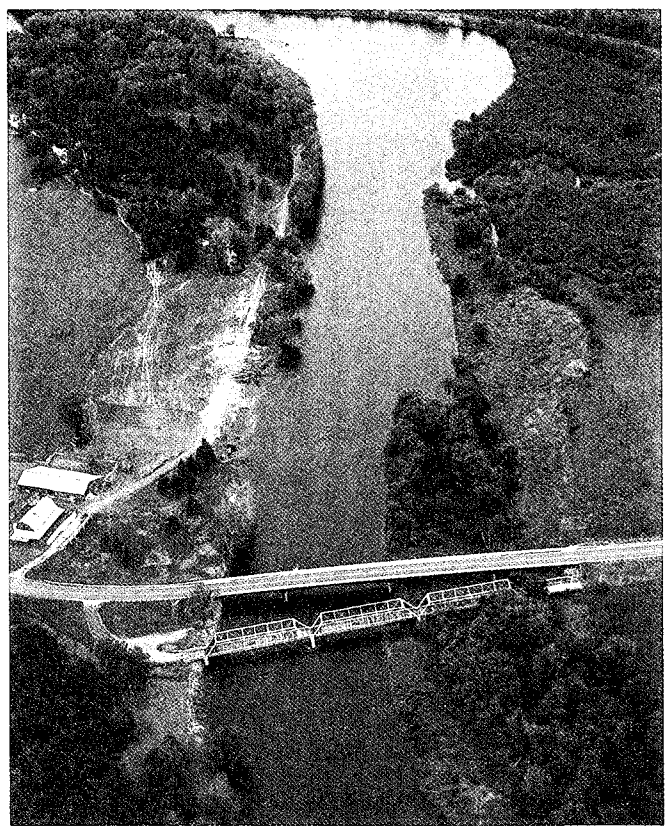
The accumulation of silt and gravel along the right bank of the river at the Easterly Bridge narrowed the river's width from approximately 400 feet to 250 feet. The restricted channel diverted the flow of the river to the left bank, resulting in considerable erosion of the bank and the undermining of a bridge pier, which threatened the bridge's stability.

The project involved placing 200 feet of stone slope pro-

Hampton Beach



About 300 feet of stone slope protection along the Connecticut River in North Stratford protect a fire station that had been threatened by erosion.



Severe erosion along the bank of the Androscoggin River at the Easterly Bridge in Shelburne had seriously undermined a bridge pier. The Corps responded by constructing 200 feet of stone slope protection upstream and downstream of the Bridge and around the pier.

Wallis Sands State Beach in Rye.

tection along the left riverbank to stabilize the bank and protect the endangered pier. The stone slope protection was constructed upstream and downstream of the Easterly Bridge and around the pier. Work took place between May-August 1977 at a cost of $37,700. It is a small project, built under Section 14 of the Continuing Authorities Program.

Wallis Sands State Beach

Wallis Sands State Beach in Rye is about five miles south of Portsmouth and about nine miles northeast of the New Hampshire-Massachusetts state line.

The project involved widening the northernmost 800 feet of the beach to a general width of 150 feet by the direct placement of sand, and constructing a 350-foot-long stone groin at the beach widening's southern limit. The work was completed in 1963 at a cost of $501,000.

The beach and groin were seriously damaged by a storm in February 1972, when much of the New Hampshire coastline was declared a National Disaster Area. The Corps completed a restoration of the beach in September 1973 at a cost of $95,000.

West Stewartstown

This project, located in the West Stewartstown section of Stewartstown, is situated along the Connecticut River in the northwest corner of the state, near New Hampshire's border with Canada and Vermont. It is about 150 miles north of Concord.

Three severe floods within a 13-month span caused serious crop damage at the farm division of Coos County Institution in West Stewartstown. In addition to a farm, this 1100-acre facility, established in 1867, includes a jail and nursing home. In June 1973, 200 feet of a privately-built earthfill dike was breached, resulting in high velocity floodwaters racing across the low-lying farm fields. About 60 acres of crops were flooded to an average depth of one to two feet, substantially eroding the topsoil. In December 1973 and in July 1974, the farm again experienced severe flooding, with the river trying to establish a new course through the farmlands.

To protect the farm fields and crops, the Corps constructed a total of 657 feet of earthfill dike with stone slope protection in two places along the left bank of the Connecticut River. The work replaces the section of dike that was breached and provides additional protection to the existing dike. The northerly dike work is 500 feet long, and the southerly dike work is 157 feet long. Although the project will not prevent overbank flooding, it will protect the farmlands from high velocity flooding and prevent further soil erosion and subsequent deposition downstream.

The project was constructed between November-December 1975 at a cost of $54,700. It is a small project, constructed under Section 14 of the Continuing Authorities Program.

Two sections of earthfill dike totalling 657 feet help protect the farmlands of Coos County Institution in West Stewartstown from high velocity flooding and soil erosion. The Corps-built sections of dike replace segments of privately-built dike weakened during heavy flooding in 1973 and 1974. Pictured above is the 500-foot-long northerly dike segment at a bend in the Connecticut River.

STUDIES

Studies

Before taking measures to resolve a water resources problem, the Corps will study the affected area to determine if a project is feasible. The study examines a wide range of potential solutions based on their economic and engineering practicality, acceptability, and impact on the environment.There are currently no Flood Damage Reduction studies ongoing in the State of New Hampshire.

APPENDIX

Communities with Corps Projects

The communities listed below have either Corps' lands or Corps-built projects lying within their borders. The listing indicates the project name, its purpose (Flood Damage Reduction, Navigation, or Shore and Bank Protection), and the page number in this booklet where the project is described.

Glossary

Anchorage—an area dredged to a certain depth to allow boats and ships to moor or anchor.

Bedrock—rock of relatively great thickness lying in its native location.

Breakwaters—structures, usually built offshore, that protect the shoreline, harbor, channels, and anchorages by intercepting the energy of approaching waves.

Bulkheads—steel sheet piling or timber walls that prevent sliding of the land and protect the streambank or shoreline from erosion.

Conduits—concrete tunnels or pipes that divert floodwaters around or under potential flood damage sites.

Culverts—large pipes, usually constructed below bridges and other water crossings, that allow water to pass downstream and provide support to the crossing.

Dikes—earthfill barriers that confine floodwaters to the river channel, protecting flood prone areas.

Drainage Area—the total land area where surface water runs off and collects in a stream or series or streams that make up a single watershed.

Drop Structure—a device in a stream or channel that prevents water from rising above a certain elevation. Once water reaches a certain level, excess water passes over the structure and is diverted to another body of water.

Earthfill—a well graded mixture of soil containing principally gravel, sand, silt, and clay, which is used with other materials to construct dams, dikes, and hurricane protection barriers.

Environmental Assessment—an examination of the positive and adverse impacts on the environment of a proposed water resources solution and alternative solutions.

Environmental Impact Statement—a detailed environmental analysis and documentation of a proposed water resources solution when the proposed solution is expected to have a significant effect on the quality of the human environment or the area's ecology.

Feasibility Study—a detailed investigation, conducted after the reconnaissance study is completed, that recommends a specific solution to a water resource problem.

Floodplain—the land adjoining a river, stream, ocean, or lake that is likely to be flooded during periods of excess precipitation or abnormal high tide.

Floodproofing—structural measures incorporated in the design of planned buildings or alterations added to existing ones that lessen the potential for flood damage. For example, existing structures could have their basement windows blocked, or structures in the design stage could be built on stilts or high foundations.

Floodwalls—reinforced concrete walls that act as barriers against floodwaters and confine them to the river channel, protecting flood prone areas. Floodwalls are usually built in areas with a limited amount of space.

Gabion Wall—a retaining wall constructed of stone-filled wire mesh baskets.

Groins—structures that extend perpendicular from the shore in a fingerlikemanner to trap and retain sand, retarding erosion and maintaining shore alignment and stability.

Hurricane Protection Barriers—structures built across harbors or near the shoreline that protect communities from tidal surges and coastal storm flooding. They are often constructed with openings for navigational purposes.

Intake Structure—found at the entrance to a conduit or other outlet facility, an intake structure allows water to drain from a reservoir or river and is equipped with a trash rack or other feature that prevents clogging from floating debris.

Jetties—structures that stabilize a channel by preventing the buildup of sediment and directing and confining the channel's tidal flow. Jetties are usually built at the mouth of rivers and extend perpendicular from the shore.

Outlet Works—gated conduits, usually located at the base of a dam, that regulate the discharge of water.

Pumping Station—a structure containing pumps that discharges floodwaters from a protected area over or through a dike or floodwall and into a river or ocean.

Reconnaissance Study—a preliminary study that examines a wide range of potential solutions to a water resources problem, each of which is reviewed for its economic and engineering practicality, acceptability, and impact on the environment.

Recreation Pool—any permanent body of water impounded by a dam that offers recreational opportunities or promotes fishery and wildlife habitat.

Retaining Walls—walls made of stone, reinforced concrete, precast concrete blocks, or gabion that support streambanks weakened by erosion.

Revetment—a facing of stone or concrete constructed along a backshore or riverbank to protect against erosion or flooding.

Sand Drain—a layer of pervious materials, such as sand and gravel, placed beneath the downstream section of a dam that carries seepage to the dam's downstream limits and out into the stream.

Sand Replishment—quantities of sand placed on a shoreline to restore or widen a beach's dimensions. Sand replenishment strengthens beaches affected by erosion, protects the backshore from wave action, and stops the inland advance of water.

Seawall—a reinforced concrete wall built along a shoreline to protect against erosion or flooding.

Snagging and Clearing—the removal of accumulated snags and debris, such as fallen trees, dead brush, and silt, from river and stream channels. Snagging and clearing improves a channel's flow capacity and eliminates a potentially dangerous flood situation.

Spillway—a channel-shaped structure, usually made of concrete or excavatedin rock, that allows water exceeding the storage capacity of a reservoir to pass through or around a dam instead of overtopping it.

Stone Slope Protection—a layer of large stones, usually underlain by a layer of gravel bedding, designed to prevent erosion from streamflow, wave attack, and runoff.

Stoplog Structure—a designed opening in a floodwall or dike that allows the passage of water during non-flood periods but closes during flood periods to prevent flooding downstream. Stoplog structures can be made of wood or steel or concrete beams.

Training Dike—a structure extending from the shore into the water that redirects the current, preventing sediment from settling and ensuring that adequate depths are maintained.

Training Wall—a structure built along channel banks to narrow the channel area, thereby controlling the velocity of the flow of water and preventing the buildup of sediment. Training walls and training dikes have the same purpose: to ensure adequate depths are maintained.

Vehicular Gate—an opening in a dike or floodwall that allows rail cars or other vehicles to pass over the structure during nonflood periods. Vehicular gates can be closed during flood periods by either stoplogs or large steel gates.

Weir—a concrete structure designed as part of the spillway that allows water to flow from the reservoir and over the spillway.

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